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L. Y. Dyrenforth..Editor

Sidney A. Stubbs..Associate Editor

G. Leighton LaFuze..Associate Editor

Raymond F. Bellamy......................................Managing Editor
Florida State College for Women

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PROCEEDINGS OF
THE FLORIDA ACADEMY OF SCIENCES
(Issued Quarterly)

Vol. 6 No. 1

EARTHQUAKES IN FLORIDA

Robert B. Campbell
Tampa, Florida

Florida is not usually included in the lists of states subject to earthquakes and mention of their possibility brings smiles of skepticism and frequently derision. But a number of earthquakes have been recorded in the State's history and they are here listed. The information comes from various sources, the two most important being Serial 609, issued by the United States Coast and Geodetic Survey, and from T.Frederick Davis' "History of Jacksonville." Those listed in Serial 609 are from the private files of Henry Fielding Reid, and from early issues of the American Journal of Science. Mr. Davis, the author of the "History of Jacksonville", was connected with the weather bureau in Jacksonville for many years and had the advantage of the records there.

Seismologists divide earthquakes into two classes, "deep focus earthquakes" and "near surface earthquakes", though there is probably no essential difference between them that is not introduced by depth factors. The deep focus earthquakes, comprising about 10% of the whole, furnish information concerning the internal constitution of the earth, as they occur from depths of 100 to 700 kilometers. Surface movements and tremors are considered by geologists to represent slippage along buried faults.

Approximately 10,000 tremors, both major and minor, are recorded annually by the world's seismographs, but it is probable that there are many thousands more that are not recorded. Twenty years ago there was hardly a seismological laboratory in the United States that could be called really first class, but today there are a number of first rank stations, and it is probable that the next decade will yield more scientific data on earthquakes than has been gathered in the past centuries. In the past, seismograph installations have been possible only at considerable expense, but such equipment is now becoming available to physics laboratories less fortunate in the matter of finances. With

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the help of a number of instruments situated in the various universities in Florida, it may be possible in the next few years to map subsurface structural trends by recording seismic activity.

In the absence of instrumental records, seismologists must accept reports from various observers, usually laymen who happen to be at the scene of seismic activity. To classify the tremors according to intensity, a 1 to 10 scale called the "Rossi-Forel" is used, which is briefly as follows:

1. Microseismic shock which is recorded by one or more seismographs of the same level. It may be felt by an experienced observer.
2. Extremely feeble shock which may be recorded by several seismographs of different kinds. It may be felt by a small number of persons at rest.
3. Very feeble shocks which must be strong enough to determine duration and direction. These may be felt by persons at rest.
4. Feeble shock which may cause disturbance of movable objects or cause cracking of ceilings. It may be felt by persons in motion.
5. Shock of moderate intensity which may disturb furniture and ring some bells. It may be felt generally by everyone.
6. Fairly strong shock causing general ringing of bells, swinging of chandeliers, arousing those asleep.
7. Strong shock causing overthrow of movable objects, fall of plaster, and general panic.
8. Very strong shock causing overthrow of chimneys and cracks in walls of buildings.
9. Extremely strong shock causing destruction of some buildings.
10. Shock of extreme intensity causing great disaster, fissures in the ground, disturbance of strata.

The record of earthquakes felt in Florida follows:

1727, October 29th. Several secondary sources report a severe earthquake in St. Augustine on this date but the original record has not yet been located. New England suffered a severe shock about 10:40 A.M. on this date, and an earthquake was reported from Martinique on the same day.

1879, January 12th. A general earthquake felt through north and central Florida from a line drawn from Punta Rassa to Daytona on the south, to one drawn from Tallahassee to Savannah on the north, an area of about 25,000 square miles. At Daytona and St. Augustine doors and windows rattled, articles were thrown from shelves, and plaster shaken down. There were two shocks of about thirty seconds each with an intensity of 6 to 8 on the Rossi-Forel scale. The Tampa account gave the time as 11:30 P.M. There, the trembling was preceded by a rumbling sound as of a distant railroad train, the undulations described as being from the southwest to the northeast. This was the first record of an earthquake felt in Tampa. The Tampa account also noted that the shock was felt at Ft. Meade.

1880, January 22nd. Severe shocks (intensity 8) were felt in Key West reflecting a disastrous earthquake in Vuelto Abajo, west of Havana. This quake was felt and rumblings heard in Western Cuba and on the Isle of Pines. It covered about 65,000 square miles.

1886, August 31st. This is the date of the great earthquake at Charleston, S. C. It was felt all over northern Florida, church bells rang in St. Augustine, and severe shocks were felt along that part of the east coast. The water disappeared from Lake Jackson at that time, and according to folk-lore the town water well at Graceville started flowing at that time. The first shock in Charleston is recorded as occuring at 9:51 P.M., and the second ten minutes later. The Tampa account gives the time there as 9:15 P.M. In Tampa there were also two shocks, the first appearing to come from south or southwest, and the second seeming to come from the north or northeast. Apparently this quake had an intensity of 5 to 6 in Florida.

1886, September 1, 3, 5, 8, and 9th. Jacksonville experienced more tremors of about 4 intensity.

1886, October 22nd. Windows and dishes rattled at Jacksonville, intensity 5. This shake was felt with a force of 7 in Charleston, Atlanta, and Augusta, and with an intensity of 8 at Summerville, S. C.

1893, June 20th. At 10:07 P.M. Jacksonville experienced a slight shock lasting about 10 seconds. Intensity 4.

1900, No date. The United States Coast and Geodetic Survey records a local shock for this year with an intensity of 5 at Jacksonville. T.Frederick Davis, Jacksonville historian, who was with the weather bureau there at the time, does not include it in his list. On being queried, he said he thought that the shock had occurred at Lake City.

1930. Frank Lovering, in his "Reporter in Paradise", lists a shock felt in Everglades, La Belle, and Ft .Myers. Its seismic origin has been questioned and blasting given as the cause. It does not seem possible to dismiss it so lightly as it would take tremendous explosions to be felt over such a wide territory. By 1930 all extensive road building and canal excavations had ceased in that part of Florida. There is also a report of windows and dishes rattling at Marco Island about this same time. The probable intensity at Marco was 5.

1935, November 13th. Two short tremors were felt at Palatka, the first at 10:10 P.M., and the second, lasting 15 seconds, at 10:30. The second shock was felt at St. Augustine and on nearby Anastasia Island, but apparently the disturbance did not extend far as other cities on the coast reported that they had no disturbances. Intensity at Palatka, 4 to 5.

1942, January 19th. The latest report of earth tremors comes from the southern part of the State, variously reported as follows: Miami reported five to seven distinct shocks of one minute duration about three minutes apart, beginning about 2:10 P.M., shaking houses and rattling windows in North Miami, at the Courthouse, and on Miami Beach. Holly wood reported five to seven one-minute shocks, shaking houses and windows, and Delray Beach reported five or six tremors each lasting several seconds. Delray Beach seems to have been the northernmost point on the east coast to feel the shocks, but Moore Haven on the southwest shore of Lake Okeechobee reported twelve tremors about 2:00 P.M. Further west, La Belle reported twelve tremors accompanied by low rumbling and ground quivering lasting from 2:05 to 2:20 P.M. The shocks seemed to be stronger in North La Belle. Alva, still further west, reported twenty

> distinct tremors, the highest number reported. In Ft. Myers nine distinct tremors, with booming sounds and severe window rattling occured about 2:00 P.M. Classes were dismissed at Iona, a nearby settlement, and reports and inquiries came by telephone from many of the neighboring islands, Boca Grande, Sanibel, Captiva and Pine Island. At Naples and Marco Island, booming and rumbling noises seemed to come out of the southwest. At Marco, four tremors were reported.

Such is the record of Florida earthquakes, and meagre as are the data, it shows that what little seismic activity has occured here is divisible into two distinct areas separated roughly by the 27th parallel, the segment to the north responding to continental structure and the southern segment with the Atlantic Region. This corresponds with recent magnetometer studies which indicate the northeast trend in the northern segment, seemingly controlled by the Appalachian folding and a trend to the southeast in the lower half of the peninsula, paralleling the Antillean folding. Already some geologists in Florida are mapping subsurface faults on data yielded by cuttings from oil tests and water wells, and through these studies, in combination with more instrument detection of seismic activity, much may be learned of Florida's subsurface.

THE SOLDIER AND NYMPHAL FORMS OF KALOTERMES (CALCARITERMES) NEARCTICUS SNYDER

E. Morton Miller
University of Miami

The only species of Calcaritermes known in the United States was recognized and described by Snyder in 1933[1] from three winged specimens collected in isolation in Clay, Levy, and Orange counties, Florida. The nymphs and soldiers of the species remained unknown until collected by the writer near Winter Park, Florida, September 12, 1940. Subsequent collections were made by Prof. A. E. Emerson and Dr. Victor Dropkin, to whom I am indebted for use of their additional material.

Alates which fit Snyder's description were raised from nymphs kept alive in the laboratory and also were collected with soldiers in nature. It is believed, therefore, that the castes herein described are to be assigned to the species *Calcaritermes nearcticus* Snyder.

Soldier.—Head sub-cylindrical, truncate anteriorly and slightly concave along dorsal line in profile; a single deep vertical furrow at the front, shallowest above the labrum and deepest at the frons. Sides of head parallel when seen in dorsal view. Head color black in front, lightening more or less abruptly to reddish brown behind the level of the antennae and to brownish yellow towards the posterior. (Some specimens lighter over whole head.) Front slightly roughened; whole head finely punctate. Mandibles reddish brown to black, somewhat reduced in size, less than one-half the length of the head when viewed laterally; two distinct teeth on right and three on left. Labrum and antennae yellowish. Antennae with ten or eleven segments nearly equal in size, excepting the basal segment. Slight shelves protruding from the head above and below the antennal socket. Eye much reduced, about 0.1 mm. in diameter; light-colored. Eye slightly dorsal to base of antennae and distant from it a space twice its own diameter.

Pronotum concave and smooth in front; sides convexly sloped inward to posterior margin; width along anterior border about two and one-half times the length of pronotum at median line.

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[1] Snyder, Thomas E. 1933. *Calcaritermes* in the United States. Proc. Ent. Soc. of Washington, 35 (5): 67-69.

Tibia of each prothoracic leg fitted distally with a conspicuous, broadly-based spur on its outer margin.

Gula brown to dark brown, lightening to yellow at anterior tip; margins usually darker; broader at middle.

One specimen from the colony showed wing buds on meso-and metanota; otherwise this individual seems typical of the description above. Another specimen is intercaste in its features, possessing a shallow frontal groove in the head and a tibial spur reminiscent of the soldier type, but also prominent wing buds, mandibles, and pigmented eyes approaching the reproductive nymph characters. Its pigmentation is nymphal. This individual appeared in the laboratory segment the colony and may represent a response to altered colony conditions.

Measurements (in millimeters): Given for the five soldiers of the Winter Park collection. The morphotype individual upon which the description is chiefly based is listed first in each series of numbers.

Head width at posterior margin—1.2, 1.2, 1.2, 1.15, 1.15

Head width at antennal level—1.15, 1.1, 1.1, 1.05, 1.05

Head length to tip of labrum—1.55, 1.75, 1.5, 1.4, 1.45

Head length to frontal furrow—1.1, 1.1, 1.15, 1.0, 1.1

Head depth (dorso-ventral) in profile—1.05, 1.0, 1.0, 1.0, 0.95

Length of left mandible, tip to condyle—0.64, 0.67, 0.62, 0.62

Width of pronotum—1.25, 1.25, 1.2, 1.1, 1.2

Length of pronotum at median line—0.45, 0.5, 0.5, 0.4, 0.4

Length of pronotum at margin—0.70, 0.65, 0.70, 0.55, 0.55

Number of antennal segments—10, 11, 11, 11, broken

Described from a total of fifteen soldiers from localities as follows:

Orlando, Florida: (Eleven miles north of Winter Park) 12. IX 1940 Coll. E. M. Miller (Morphotype colony)

Bartow, Florida: 24. XI. 1940 Coll. E. M. Miller

Ortega, Florida: 17. III. 1941 Coll. A. E. Emerson

Ortega, Florida: 17. III. 1941 Coll. Victor Dropkin

Nymphs.—The nymphs seem to present no features unusual to *Kalotermes,* with the exception of a slightly raised median mesonotal area upon which appear numerous reddish asperities. A similar character has been noted by Dr. T. E. Snyder[2] for *Calcaritermes emarginicollis,* and it was at his suggestion that the condition was observed in nymphs of *C. nearcticus.*

Samples of the material used are in the collections of the U. S. National Museum (No. 161193), A. E. Emerson, and Thomas E. Snyder.

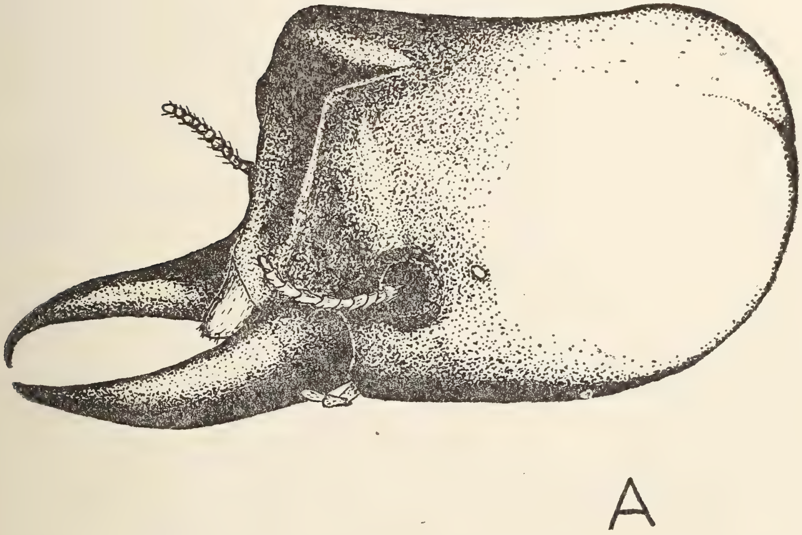

Fig. 1.—Soldier of *Calcaritermes nearcticus* Snyder. A, Head in fronto-lateral view.

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[2] Snyder, Thomas E. 1926. Five New Termites from Panama and Costa Rica. Proc. Ent. Soc. Washington, 28(1): 13.

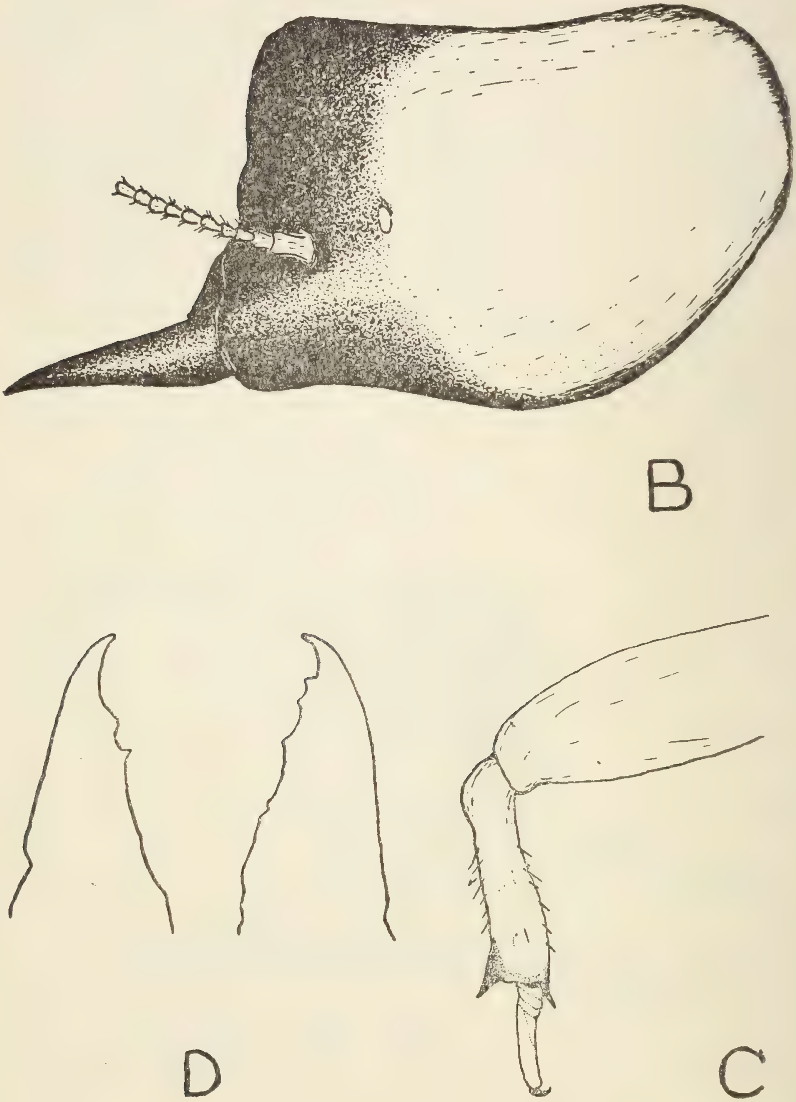

Fig. 2. Soldier of *Calcaritermes nearcticus* Snyder. B, Head in lateral view. C, Portion of left fore-leg showing tibial spur. D, Right and left mandibles in ventral view. All approx. x50.

THE CORRELATION OF SOIL pH WITH DISTRIBUTION OF WOODY PLANTS IN THE GAINESVILLE AREA

Wilbur B. De Vall
University of Florida

The relationship that exists between plants and the complex soil medium in which they grow has been investigated by many authors. Each in turn has sought to discover a more intimate dependency of vegetative forms on the soil and its constituents. That this dependency does exist is brought out by Kurz,[1] Berkman[2] and others with reference to local areas and selected plant species. Most of these investigations dealing with the plant-soil relationship have been carried out by ecologists in the eastern half of the United States.

In reviewing the literature pertaining to this one phase of plant environment, namely pH of soils as related to plant distribution, it is obvious that many of the investigators accept the fact that this relationship does exist and merely mention it in their papers without an explanation as to how this dependency came about or how it might be used. The papers also reveal that actual data pertaining to the pH of soils as related to tree distribution is scattered and fragmentary. Young[3] gives some very pertinent data for several northern hardwoods but only as a routine part of an ecological study.

Many ecologists strive to show that even though soil acidity and alkalinity are affected by many climatic, physiographic and biotic factors, much can be understood about the distribution of plants when only the pH of the soil is taken into consideration. There are certain plants that require acid soils and others that require alkaline soils. Such plants are generally classed as acidophiles and acidophobes, respectively. For instance, cranberries can only be grown satisfactorily in acid soils whereas alfalfa makes its best growth on a soil nearly neutral or slightly on the alkaline side. Such extremes may be found to exist with woody plants. If all plants were tolerant over a wide range of pH values, the forest types of the country would be much more complex than we know them today.

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[1] Herman Kurz, "The relation of pH to plant distribution in nature," *Amer. Nat.*, Vol. 64, (693) (1930), pp. 314-41.

[2] Anton H. Berkman, "The pH of some Texas soils and its relation to the incidence of certain woody plant species," *Soil Sci.*, Vol. 25 (1928), pp. 133-42.

[3] Vernon A. Young, "Plant distribution as influenced by soil heterogeneity in Cranberry Lake region of the Adirondack mountains," *Ecology*, Vol. 15, No. 2 (1934), pp. 177-80.

It is the purpose of this paper to show how some woody plants may be used, alone or in communities, as indicators of soil pH. These data are not applicable to the State as a whole but will serve as a preliminary step in the process of accumulating more useful pH data as a basis for further eco-edaphic studies.

SCOPE OF THE INVESTIGATION

This study was begun in September 1939 to obtain specific data on soil acidity pertaining to two major species of Florida pine, longleaf pine (*Pinus australis* Michx. f.) and swamp pine, (*Pinus palustris* Mill.) In February 1940 it was thought advisable to extend this to include other dominant woody plants.

The approach to the latter part of this investigation was considered from three points of view. First, to select representative soil types within the Gainesville area and run pH determinations for these soils, recording all woody plants indigenous to the soil type. The second approach considered was to study various plant habitats that might differ with respect to drainage, exposure and competitive vegetation. The third approach and the one actually followed was to make all pH determinations on the basis of individual forest types. In some respects this varies but little from the former, but is an approach based primarily on species and species distribution, rather than differences in the edaphic factors and environment.

LOCATION AND DESCRIPTION OF STUDY AREAS

The major forest types encountered in this area are, (1) pine flatwoods, (2) mixed hardwood hammock, (3) scrub oak ridge and (4) cypress-tupelo ponds. The areas selected for study covered all of these except the latter. Due to partial, or in some cases complete inundation, sampling in ponds was not feasible. The hammock forest type contains a more diversified group of woody plants than does any of the others and therefore the number of samples taken and number of areas studied was greater for this than for the flatwoods or oak ridge types.

Each area is somewhat different as regards topography, drainage and soil so that a brief description of each will be given. The seven areas sampled were as follows:

1. *Hogtown Creek Hammock*—This hardwood area follows a small creek and extends some four-hundred to eight-hundred feet on either side. Most of the wooded portion is well-drained except near the stream and at certain periods of the year when the stream overflows its banks. Sampling in this area was confined as far as possible

to portions of the forest not disturbed by high water. The hammock is situated just north and west of the Gainesville city limits in a shallow valley. The slopes are largely old fields grown up to loblolly pine, (*Pinus* taeda L.). The soil type is Norfolk fine sand.

2. *Austin Cary Forest*—This forest comprises 2,083 acres, certain portions of which are in the oak ridge type, hammock type and pine flatwoods. The tract is located on State Highway 13, approximately eight miles northeast of Gainesville. The predominant soil type is Leon fine sand.

3. *Rattlesnake Branch Area*—This area consists of a narrow belt of hammock. A small meandering stream has cut a narrow ravine through a strata of clay, exposing in some places small areas of limestone. Several seepage areas may be found along the banks of the stream which in part accounts for a widely varigated flora. It is located at the north edge of the city limits at its western extremity on Norfolk fine sand.

4. *Sugarfoot Hammock*—This area is an extensive hammock located about three miles south and west of Gainesville. Approximately one-hundred acres may be included in the area over which samples were taken. Adjacent to the hammock is an extensive prairie. Topography within the hardwood area varies from flat, partially inundated prairie margin through a well-drained hammock to a high hammock with occasional exposed limestone. Trees in this area are of a more mature class than any other hammock type studied. The prevailiing soil type is Norfolk fine sand.

5. *Newnan's Lake Area*—The area is located about four miles east of this city on the west side of Newnan's lake. Samples were taken over an extensive area so as to include four major habitats and two types. A scrub oak ridge gradually blends into a hardwood swamp bordered by a narrow margin of low pineland. To the east of the swamp, the topography rises to a high hammock which again diminishes rather abruptly to the lake shore. The species composition of the hammock is uniform with a much different flora than was found in the previously described areas. The general soil type is Norfolk fine sand.

6. *Magnesia Springs Area*—Magnesia spring is located one mile south of Grove Park, Florida, adjacent to Lochloosa Creek. This area was chosen for a comparative study because it is composed of numerous soil types and is a very low, poorly-drained hammock. Much of the area surrounding the spring is underlain with limestone. Again a distinct flora characterizes the area, as compared with the other locations. Soil types in this area are too complex to enumerate here.

7. *Buzzards Roost*—This small limestone outcrop located about eight miles west of Gainesville on the Newberry highway has been so named by local naturalists and suggested a contrasting type for this study. Here the limestone is exposed at the surface and at the base of the outcrop a heavy clay soil is present. The wooded area is about an acre in extent and is surrounded by a tung tree, (*Aleurites fordi* Hemsl.) plantation. Several species found here are represented only in remote places in the Gainesville area.

METHODS AND PROCEDURE

Field procedure

A general familiarity with plant associations in the vicinity of Gainesville led to the selection of the previously described study areas. Within each area plants were found to group themselves into colonies or communities; thus a randomized sampling method was deemed best suited to determine the soil pH for each mixture or group of species.

The selection of the spot to be sampled was determined by the presense of major tree species; the associated species were recorded as minor species. Major species as used here means any tree in the area that is obviously a permanent component of the community or that is outstanding because of its presence. In a few instances, samples were taken where a rare and infrequent tree was found. In addition to the above, areas were selected to get representations of all trees under different conditions rather than to accumulate any definite number of samples for a single species. However, in the event that a species was so abundant as to be represented in several samples, it was continually recorded along with its associates. Samples in each separate, yet similar type were so taken as to duplicate species found in previously sampled areas; also, so that comparative pH values might be obtained and a general range of acid- or alkaline-tolerance determined for the species.

The soil sample was taken as a vertical section of the first six inches of mineral soil, exclusive of duff or litter. This was obtained by first digging a small hole approximately six inches in diameter and eight inches deep. The sample was taken from the side of this hole with a hand spade and place in a paper bag, properly labeled; any peculiarities of the sub-soil, surface soil or litter were recorded.

The data for each sample as regards the flora were taken in the following manner. Using the location of the sample as a center, all trees within a radius of twenty feet were tallied; also all associated shrubs within a radius of ten feet. These radii were taken as a conservative distance that the tree or shrub would send out lateral feeding roots and would therefore be dependent upon the soil from which the sample was taken.

Laboratory procedure

All samples were taken into the laboratory and allowed to reach an air-dry condition before pH determinations were made. When thoroughly air-dry at room temperature a portion of the sample (10 grams) was tested in water solution for pH using the Coleman, glass-electrode, pH meter.

In addition to the determinations on the Coleman instrument a series of check tests was made on the same samples by R. A. Carrigan of the Florida Agricultural Experiment Station, using a glass-electrode with a Leeds and Northrup electrometer. The procedure used in preparing samples for the check tests was, (1) to dry the sample at room temperature, (2) screen through a 2mm. sieve to remove debris, and (3) mix the screened material thoroughly before testing. This method used a 50 cc. beaker of soil mixed with 100 cc. of distilled water to make the soil extract.

These tests were made as a check or comparison of the two glass-electrode instruments as well as the technique used in the determinations. The average algebraic difference, using the second method as a standard, was ± .22.

PRESENTATION AND ANALYSIS OF DATA

Ecologists in general have dealt with plants and plant communities in much the same manner that sociologists have dealt with people. Plant communities are limited in their ways and means of advancement and encroachment upon other plant communities. Thus, there is a stage beyond which these groups find they cannot move into regions in which they are not wanted or in other words, in which they cannot compete and maintain themselves. This degree of limitation is expressed as fidelity. The use of this term with relation to a study in plant distribution means the sociological distribution of a species. As all plants do not show the same sociological tendencies, degrees of fidelity have been devised to express this limitation. The five degrees of fidelity under which most plants can be classed are as follows:

Fidelity class 5—Plants that are confined to one community; exclusive species.
Fidelity class 4—Plants that are most frequent in a given plant community; selective species.
Fidelity class 3—Plants that occur in one community more than in another; preferential species.

Fidelity class 2—Plants that are limited to no definite community; indifferent species.
Fidelity class 1—Plants that are of rare occurrence and may be found as intruding on a community unlike their own; strange species.

The analysis which follows has been divided into three parts namely, (1) forest type analysis, (2) habitat analysis, and (3) species analysis. The previous fidelity classes will be employed in the species analysis to show the relationship between species and soil pH.

Forest Type Analysis

This analysis is conveniently made in tabular form to show, (1) the location of the study area, (2) the forest type, (3) the major species of the type and (4) the minor species, inclusive of trees and shrubs. This classification is shown in Table 1.

TABLE 1—Classification of Major and Minor Species by Forest Types

Forest type	Major species	Minor species
	1. HOGTOWN CREEK AREA	
(Hammock)	*Acer floridanum* Pax. *Acer negundo* L. *Catalpa bignonioides* Walt. *Fraxinus americana* L. *Hicoria glabra* (Mill.) Brit. *Liquidambar styraciflua* L. *Magnolia grandiflora* L. *Pinus glabra* Walt. *Prunus serotina* Ehrh. *Quercus laurifolia* Michx. *Tilia crenoserrata* Sarg.	*Acer rubrum* L. *Baccharis halimifolia* L. *Osmanthus americana* B. & H. *Ostyra virginiana* (Mill.) Willd. *Prunus caroliniana* Ait. *Quercus austrina* Small. *Sambucus simsonii* Rehder. *Sebastina ligustrina* (Michx.) Muell. Arg.
	2. AUSTIN CARY FOREST	
(Flatwoods)	*Pinus australis* Michx. f. *Pinus palustris* Mill.	*Myrica pumila* Michx. *Serenoa repens* (Bartr.) Small.
(Oak Ridge)	*Quercus catesbaei* Michx. *Quercus cinerea* Michx. *Quercus margaretta* Ashe.	*Diospyros virginiana* L. *Quercus geminata* Small. *Xolisma ferruginea* (Walt.) Heller
(Hammock)	*Acer rubrum* *Liquidambar styraciflua* *Magnolia grandiflora* *Nyssa biflora* Walt.	*Alnus rugosa* (Du Roi) Spreng. *Cephalanthus occidentalis* L. *Gordonia lasianthus* (L.) Ellis *Myrica cerifera* L. *Persea borbonia* (L.) Pax. *Pinus palustris* *Viburnum sp.* (Tourn.) L.

TABLE 1—Classification of Major and Minor Species by Forest Types
Continued

Forest type	Major species	Minor species
	3. RATTLESNAKE BRANCH AREA	
(Hammock)	*Hicoria glabra* *Liquidambar styraciflua* *Magnolia grandiflora* *Pinus taeda* L. *Quercus prinus* L.	*Aesculus pavia* L. *Aralia spinosa* L. *Carpinus caroliniana* Walt. *Cercis canadensis* L. *Ilex opaca* Ait. *Myrica cerifera* *Osmanthus americana* *Ostrya virginiana* *Prunus serotina*
(Old Field)	*Pinus taeda* *Quercus laurifolia*	*Prunus augustifolia* Marsh.
	4. SUGARFOOT AREA	
(Oak Ridge)	*Quercus catesbaei* *Quercus falcata* Michx.	*Crataegus sp.* L.
(Prairie Margin)	*Acer rubrum* *Liquidambar styraciflua* *Nyssa biflora* *Pinus taeda*	
(Hammock No. 1)	*Magnolia grandiflora* *Quercus laurifolia* *Quercus virginiana* Mill.	*Liquidambar styraciflua* *Vaccinium arboreum* Marsh.
(Hammock No. 2)	*Magnolia grandiflora* *Persea borbonia* *Quercus laurifolia* *Quercus prinus*	*Prunus serotina* *Ulmus alata* Michx.
(Hammock No. 3)	*Acer negundo* *Celtis laevigata* Willd. *Magnolia grandiflora* *Quercus prinus* *Tilia crenoserrata*	*Aesculus pavia* *Callicarpa americana* L. *Carpinus caroliniana* *Cercis canadensis* *Cornus florida* L. *Liquidambar styraciflua* *Ostrya virginiana* *Xanthoxylum clava-herculis* L.
(Stream bank)	*Acer rubrum* *Fraxinus caroliniana* Mill. *Liquidambar styraciflua* *Planera aquatica* (Walt.) Gmel.	*Baccharis halimifolia* *Cephalanthus occidentalis* *Myrica cerifera*

TABLE 1—CLASSIFICATION OF MAJOR AND MINOR SPECIES BY FOREST TYPES
Continued

Forest type	Major species	Minor species
5. NEWNANS LAKE AREA		
(Hardwood Swamp)	*Acer rubrum* *Liquidambar styraciflua* *Magnolia virginiana* L. *Nyssa biflora*	*Cephalanthus occidentalis* *Myrica cerifera* *Sambucus simpsonii*
(Oak Ridge)	*Quercus catesbaei* *Quercus geminata* *Quercus myrtifolia* Willd. *Xolisma ferruginea*	
(Hammock)	*Celtis laevigata* *Hicoria glabra* *Ilex opaca* *Magnolia grandiflora* *Persea borbonia* *Quercus laurifolia*	*Callicarpa americana* *Crataegus sp.* *Diospyros virginiana* *Morus nigra* L. *Ostrya virginiana* *Vaccinium arboreum* *Xanthoxylum clava-herculis*
(Low Hammock)	*Liquidambar styraciflua* *Magnolia grandiflora*	*Aralia spinosa* *Quercus nigra* L.
	Taxodium ascendens Brong. *Taxodium distichum* (L.) Rich.	
6. MAGNESIA SPRINGS AREA		
(Old Field)	*Pinus taeda*	
(Flatwoods)	*Pinus australis*	*Asimina angustifolia* Gray.
(Low Hammock)	*Acer rubrum* *Fraxinus americana* *Juniperus silicicola* (Small) Bailey *Magnolia virginiana* *Nyssa biflora* *Quercus laurifolia* *Sabal palmetto* (Walt.) Todd. *Tilia crenoserrata*	*Baccharis halimifolia* *Callicarpa americana* *Carpinus caroliniana* *Fraxinus caroliniana* *Sabal minor* (Jacq.) Pers. *Viburnum sp.*
7. BUZZARDS ROOST AREA		
(Limestone Outcrop)	*Acer negundo* *Celtis laevigata* *Fraxinus americana* *Hicoria glabra* *Juniperus silicicola* *Liquidambar stryaciflua* *Melia azedarach* L. *Quercus prinus* *Quercus shumardii* Buckl. *Tilia crenoserrata*	*Cercis canadensis* *Cornus stricta* Lam. *Euonymus americanus* L. *Morus nigra* *Ostrya virginiana* *Prunus caroliniana* *Rhus copallina* L. *Sambucus simpsonii* *Ulmus alata*

Habitat Analysis

The habitat analysis was made to determine whether or not a possible correlation exists between the number of times a species occurred in similar yet separate types and the range of pH values over which the species was found as a major component of the type. The phrase, "range of pH values," as used here is a figure representing the difference between maximum and minimum pH recorded for the species.

The hammock type was most intensively studied, comprising seven separate study areas; other types included were (1) oak ridge with three areas, (2) old field with two areas and (3) pine flatwoods representing two separate areas.

Hammock type

The seven areas classed as hammock are not to be compared on an equal basis from the standpoint of edaphic factors. Since each of the areas supported hardwoods, exclusive of scrub species, all were classed as hammock. All but one of the areas was adjacent to a stream or lake and on either low land or in a ravine. The one exception to this was area No. 7 at Buzzards Roost, a limestone outcrop.

Magnolia grandiflora and *Liquidambar styraciflua* were present as major species in five out of the seven areas studied. Those species having an occurrence of four out of seven were, *Fraxinus americana, Hicoria glabra, Quercus laurifolia* and *Tilia crenoserrata.* An intermediate group of species occurring in only three areas consisted of *Acer negundo, Quercus prinus* and *Celtis laevigata.* The fourth frequency class or those species found in only two of the areas, consisted of *Nyssa biflora, Acer rubrum, Persea borbonia* and *Juniperus silicicola.* Those species showing the lowest frequency, i. e., occurring in only one out of the seven areas were, *Sabal palmetto, Magnolia virginiana, Prunus serotina, Pinus glabra, Acer floridanum, Catalpa bignonioides* and *Pinus taeda.*

It is significant to note that those species with the highest frequency are the most abundant. It is highly probable that had each area been identical as to soil, drainage and exposure, some species would have occurred in all areas. No species was found in more than five out of seven areas. *Magnolia grandiflora* and *Liquidambar styraciflua* represent a frequency of about 71, or expressed differently, might be found in similar hammock types in 71% of such cases.

The significance of the above data can best be shown in graphic form, Fig. 1. This graph shows a possible correlation between acid tolerance and frequency of the species in various comparable hammocks. Regardless of the fact that there were several variables in the study, such as, number of soil samples analyzed to obtain the pH range for each species as well as differences in soil type, the data presented show a significant trend. This graph is based upon eighteen major species found in the hammock type and includes all of the previously mentioned species except *Magnolia virginiana* and *Catalpa bignonioides*. The straight line on the graph represents the average pH for each frequency class. The distribution of values regardless of species is outlined with a dotted line. Using the average for each frequency class, the graph may be interpreted as showing a correlation between pH tolerance and frequency of occurrence of the species in the hammock type. The graph also shows that as the frequency of occurrence of the species increases the difference betwen maximum and minimum pH values becomes greater. Therefore, any species which is a common con-

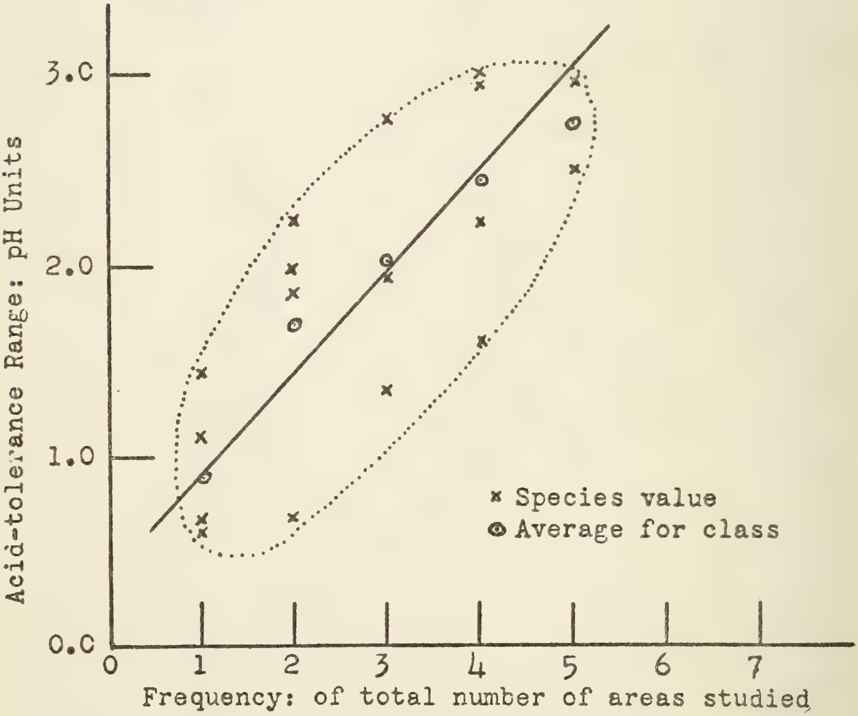

Fig. 1.—Graph showing correlation between species frequency and acid tolerance for the hammock type.

stituent of the hammock type over wide areas, would be expected to tolerate a wide range in pH values, whereas one found only occasionally in the same type would indicate a lower degree of acid-tolerance, or a narrower pH range.

However, it must be recognized here that there are many other factors which may be either directly or indirectly responsible for this relationship but as this analysis is made on the basis of soil pH and plant distribution only, the trend is significant.

Oak Ridge type

The oak ridge type was studied in the Austin Cary Forest, Newnans Lake area and Sugarfoot Prairie area. *Quercus catesbaei* is the major species inhabiting the ridge in all of these areas. Although *Quercus cinerea* was recorded only in the Forest area, it is highly probable that this species should rate next to the former species. Species found in the ridge type having a frequency of one, were *Quercus geminata*, *Q. falcata*, *Q. margaretta*, *Q. myrtifolia* and *Xolisma ferruginea*. In all cases species having a frequency of one, normally attain their maximum growth on a similar yet somewhat different type of soil than that found in the ridge type.

Flatwoods type

The flatwoods type makes up the largest percentage of forest land in Alachua county. However, the extensiveness of the type in area is inversely proportional to the number of major woody plants associated with it. Since pines usually constitute the major woody vegetation, an extensive investigation of this type was not deemed necessary. Data included in a separate study has been combined with that on the two areas in the present investigation as a basis for the type analysis. The two areas included here are the Austin Cary Forest and Magnesia Springs. *Pinus australis* was the dominant species on both sites while *P. palustris* occurred in the Forest area only. Associated species were *Serenoa repens* and *Myrica pumila* on the former and *Asimina augustifolia* on the latter.

Old Field

Determinations of soil pH were made on two old field areas merely to obtain values for *Pinus taeda* which is a frequent invader of this type of land. On the old field adjacent to Rattlesnake branch, *Quercus laurifolia* and *Pinus taeda* were the major species. The old field located near Magnesia Springs produced a pure, dense stand of *Pinus taeda*. There were no distinctive minor species in these locations.

Species Analysis

An analysis of the data on the basis of individual species would require several pages of descriptive explanations, relationships and exceptions. With this in mind the sixty-eight species with their respective ranges of pH-tolerance have been listed alphabetically in Table 2. This listing includes seven species of Gymnosperms and sixty-one species of Angiosperms. Plants previously listed as major and minor species have necessarily been mixed together so as to have all plants in alphabetical order.

TABLE 2—TABULATION OF pH DATA PERTAINING TO SPECIES COVERED IN THE STUDY

Species	No. Soil Samples	Observed pH Range Minim.	Maxim.	Diff.
Acer floridanum	2	5.21	5.82	.61
Acer negundo	5	5.21	7.97	2.76
Acer rubrum	3	5.60	7.59	1.99
Aesculus pavia	3	5.73	6.50	.77
Aralia spinosa	2	5.41	6.76	1.35
Baccharis halimifolia	3	5.60	6.61	1.01
Bignonia capreolata	1	5.79	x	x
Callicarpa americana	4	5.73	7.38	1.65
Carpinus caroliniana	5	5.01	7.18	2.17
Catalpa bignonioides	1	5.21	x	x
Celtis laevigata	9	5.99	7.97	1.98
Cephalanthus occidentalis	1	5.72	x	x
Cercis canadensis	6	5.80	7.38	1.58
Cornus florida	1	x	6.37	x
Cornus stricta	2	6.59	7.35	.76
Crataegus sp.	4	5.46	7.02	1.56
Diospyros virginiana	3	5.76	7.02	1.26
Euonymus americanus	2	6.70	7.97	1.27
Fraxinus americana	4	5.73	7.35	1.62
Fraxinus caroliniana	2	6.61	7.59	.98
Hicoria glabra	9	5.01	7.97	2.96
Ilex opaca	5	4.20	7.08	2.88
Juniperus silicicola	6	5.73	7.97	2.14
Liquidambar styraciflua	11	4.20	6.71	2.51
Magnolia grandiflora	12	4.20	7.18	2.98
Melia azedarach	2	5.99	7.97	1.98
Morus nigra	2	6.39	7.35	.96
Muscadina rotundifolia (Michx.) Sm.	1	4.20	x	x
Myrica cerifera	2	4.59	5.72	1.13
Myrica pumila	1	5.50	x	x

TABLE 2—TABULATION OF pH DATA PERTAINING TO SPECIES COVERED IN THE STUDY
Continued

Species	No. Soil Samples	Observed pH Range Minim.	Maxim.	Diff.
Nyssa biflora	2	5.72	7.59	1.87
Osmanthus americana	4	5.73	6.76	1.03
Ostrya virginiana	10	5.01	7.97	2.96
Persea borbonia	3	6.02	6.71	.69
Pinus australis	15	4.33	5.37	1.04
Pinus glabra	3	5.21	5.82	.61
Pinus palustris	22	3.80	5.22	1.42
Pinus taeda	5	4.78	5.90	1.12
Prunus augustifolia	1	5.80	x	x
Prunus caroliniana	2	5.82	7.97	2.15
Prunus serotina	3	5.76	6.43	.67
Quercus austrina	1	5.68	x	x
Quercus catesbaei	2	5.46	6.20	.74
Quercus cinerea	1	5.06	x	x
Quercus falcata	2	5.46	6.59	1.13
Quercus geminata	3	5.20	5.46	.26
Quercus laurifolia	6	4.20	7.18	2.98
Quercus margaretta	2	5.21	6.20	.99
Quercus myrtifolia	1	5.39	x	x
Quercus nigra	1	5.41	x	x
Quercus prinus	6	6.02	7.38	1.36
Quercus shumardii	4	5.99	7.97	1.98
Quercus virginiana	1	4.20	x	x
Rhus copallina	2	6.61	7.97	1.36
Rubus trivialis Michx.	1	x	7.38	x
Sabal minor	1	5.73	x	x
Sabal palmetto	2	5.73	7.18	1.45
Sambucus simpsonii	3	5.60	5.99	.39
Sebastiana ligustrina	1	5.79	x	x
Taxodium ascendens	1	5.25	x	x
Taxodium distichum	1	5.25	x	x
Tilia crenoserrata	6	5.73	7.97	2.24
Ulmus alata	3	6.02	7.35	1.33
Ulmus floridana Chapm.	1	5.99	x	x
Vaccinium arboreum	2	4.20	6.34	2.14
Viburnum sp.	1	6.61	x	x
Xanthoxylum clava-herculis	2	7.08	7.38	.30
Xolisma ferruginea	4	4.44	5.76	1.32

The following analysis is made with reference to Table 2. On the basis of sixty-eight species, (1) twenty-eight species occurred on definitely alkaline soils, (2) twenty-eight species were found on neutral soils, (3) forty-one species were found on slightly acid soils, i. e., a pH of 6.0-7.0, (4) fifty species occurred on moderately-acid soils ranging from a pH of 5.0-6.0, (5) twelve species were found inhabiting strongly acid soils with a pH of 4.0-5.0, and (6) one species, *Pinus palustris* was found on a very acid soil, the pH of which was 3.80.

The largest single group of species studied was the genus *Quercus*. Twelve species were included and may be segregated into three general groups as indicators of soil pH. Group 1, indicating very acid soils, consists of *Quercus virginiana* which was found on soils more acid than any other species with the possible exception of *Q. laurifolia*; this depending upon the type of hapitat considered for the latter species Group 2, consists of those species indicating a moderately acid soil, pH of 5.0-6.0 and includes mostly the scrub oaks such as *Quercus catesbaei, Q. margaretta, Q. geminata, Q. myrtifolia, Q. cinerea* and possibly two other commercial species, *Q. nigra* and *Q. austrina*. Group 3, may be said to indicate slightly acid to slightly alkaline soils, with a pH of 6.0-8.0, and includes the more commercial species such as *Q. prinus, Q. falcata, Q. shumardii* and *Q. laurifolia*.

Fidelity Rating

The meaning of the word fidelity was explained previously. Fidelity classes are used in this analysis as a means of segregating groups of species off by themselves, based upon similar and dissimilar sociological tendencies to mix with other plants in a large number of plant communities or to be restricted to a habitat of its own.

In this investigation, it was found that certain species were only represented in remote locations of a habitat and then only by a small number of individuals. These plants would be suggestive of fidelity Class 5 or species that are confined to one community for various reasons. These reasons may be soil type, pH, moisture or perhaps tolerance. Fidelity Class 5 should not be confused with Class 1. Class 1 recognizes such plants as are of infrequent occurrence in a community unlike their native one. Plants that have been introduced by man into a new locality or plants that may have taken up their new abode after transportation by wind, water or mechanical means into a new area, would be considered as strange species and placed in Class 1. The intermediate classes two, three and four, in their respective order show an increasing tendency for plants to become more selective in their habitat requirements.

TABLE 3—FIDELITY-CLASS RATING OF WOODY PLANTS FOUND IN THE GAINESVILLE AREA

		Fidelity-Class Rating (Trees)		
1. Strange Species	2. Indifferent Species	3. Preferential Species	4. Selective Species	5. Exclusive Species
Catalpa bignonioides		*Acer negundo*	*Celtis laevigata*	*Acer rubrum*
Melia azedarach	*Carpinus caroliniana*	*Cornus stricta*	*Cercis canadensis*	*Acer floridanum*
Morus nigra	*Crataegus sp.*	*Ilex opaca*	*Cornus florida*	*Fraxinus caroliniana*
Quercus austrina	*Diospyros virginiana*	*Osmanthus americana*	*Fraxinus americana*	*Juniperus silicicola*
Quercus myrtifolia	*Liquidambar styraciflua*	*Pinus australis*	*Hicoria glabra*	*Myrica cerifera*
Ulmus floridana	*Magnolia grandiflora*	*Prunus augustifolia*	*Persea borbonia*	*Nyssa biflora*
	Ostyra virginiana	*Quercus falcata*	*Pinus glabra*	*Quercus catesbaei*
	Pinus taeda	*Quercus virginiana*	*Pinus palustris*	*Quercus cinerea*
	Quercus laurifolia	*Sabal palmetto*	*Prunus caroliniana*	*Quercus geminata*
	Quercus nigra	*Vaccinium arboreum*	*Prunus serotina*	*Quercus margaretta*
	Rhus copallina	*Viburnum sp.*	*Quercus prinus*	*Quercus shumardii*
	Tilia crenoserrata	*Xanthoxylum clava-herculis*	*Ulmus alata*	*Taxodium ascendens*
				Taxodium distichum
		Fidelity-Class Rating (Shrubs and Woody Vines)		
	Bignonia capreolata	*Aralia spinosa*	*Aesculus pavia*	*Baccharis halimifolia*
	Muscadina rotundifolia	*Callicarpa americana*	*Rubus trivialis*	*Cephalanthus occidentalis*
		Sebastina ligustrina		*Euonymus americanus*
				Myrica pumila
				Sabal minor
				Sambucus simpsonii
				Xolisma ferruginea

The sixty-eight species have been classified into these five fidelity classes as based upon the author's interpretation of the data and a knowledge of the general distribution and adaptation qualities of the species. This listing is found in Table 3.

The fidelity table shows that of a total of sixty-eight species of woody plants, six trees are classed as strange or intruding species; eleven trees and two shrubs as indifferent to the type of habitat in which they will grow; twelve trees and three shrubs prefer one type of habitat to another although they may grow in another if conditions are favorable; twelve trees and two shrubs are listed as selective species in that they are generally found in a given type of habitat due to a selective quality of the species; and thirteen trees and seven shrubs are classed as exclusive in nature because their occurrence shows a definite dependency of the plant upon some edaphic or environmental factor or factors and therefore is seldom found outside its native habitat.

This classification as to fidelity class may be used to advantage by way of comparison with the previous discussion on pH and the acid-tolerance range of species. It must be kept in mind that the fidelity rating is not a mechanical rating but is a listing as deemed adequate by the writer to show how these species differ in their natural selection of plant communities based upon their degree of natural adaptiveness to soil pH.

Summary

1. Plant and soil research workers have shown that pH of soils is an important factor in limiting or furthering the distribution of plants.
2. The major forest types found in the Gainesville area are flatwoods pine land, mixed hardwood hammock, scrub-oak ridge and cypress-tupelo ponds.
3. Similar forest types may consist of a varied composition of species as a result of variation in the underlying soil structure.
4. Each woody plant in a given habitat may be classed as a major or minor species based upon its growth and occurrence as suggestive of permanency.
5. There is a certain degree of correlation between pH and habitat as well as pH and species distribution.
6. Woody plants group themselves into certain fidelity classes based upon their sociological tendencies and these species may be used as indicators of soil pH within certain limits, based upon a knowledge of the habitats involved.

BIOLOGICAL EFFECTS OF NEUTRON RADIATION

Arthur A. Bless
University of Florida

Neutrons are the primary constituents of the nuclei of atoms. They are particles with a mass as large as the proton, the nucleus of the hydrogen atom, but have no charge. Because of the neutral character of these particles and their minute size they can travel through materials undisturbed by the negatively charged electrons around the nuclei of atoms or by positively charged nuclei. For this reason they can penetrate with ease great thicknesses of material.

A stream of neutrons may be produced by bombarding atoms of low atomic weight with high speed particles. At first such streams were produced by the bombardment of light materials, such as berillium, with alpha particles from radium C or from radon. The bombardment resulted in the creation of carbon with the liberation of a neutron in accordance with the reaction

$${}_4\mathrm{Be}^9+{}_2\mathrm{He}^4+{}_6\mathrm{C}^{12}+{}_0\mathrm{n}^1$$

where the numbers on the lower left hand corner refer to the charge on the particle, while those at the upper right hand corner refer to the atomic weight. The neutron traveling through matter neither affects the material nor is affected by it, except in those rare cases where it strikes the nucleus of an atom of light atomic weight, such as a proton. The proton may be ejected, and the passage of this charged particle leaves an ionized track which may be detected by a suitable device, such as a Gieger counter or a Wilson cloud chamber.

Very early in the study of neutrons it was observed that these particles pass through great thicknesses of materials of high atomic weight but are comparatively easily absorbed by materials of low atomic weight. A small slab of paraffin absorbs a greater fraction of neutrons than a slab of lead many times thicker. It is not difficult to understand the reason for this behavior. When a neutron strikes a heavy nucleus it bounces off with undiminished speed after the encounter. On the other hand if it strikes a light nucleus, such as a proton, it may stop altogether, and the proton may proceed with the speed of the impinging neutron. The situation is similar to a billiard ball striking a large cannon ball or striking another billiard ball. In the first case it will rebound with undiminished speed, while in the second case it may give up all of its energy and stop altogether. The energy of the neutrons is thus easily absorbed by atoms of low atomic weight.

The fact that neutrons may be stopped by substances of low atomic weight suggested at once the possibility that these particles would be stopped by biological materials, since these are usually of low atomic weight, and that they would exert great biological effects. A great deal of experimental evidence is now abailable, and some conclusion may be drawn from these experiments.

As stated earlier, the passage of neutrons through material leaves the material undisturbed because of the neutral character of the particles. Neutrons betray their presence only when they strike and eject the nucleus of hydrogen or of some other light particle. The intense electric field around the proton causes the disruption and ionization of atoms through which it passes, and a strongly ionized path is left in its wake. The ionization of the material creates forces and chemical reactions which result in biological effects. In this respect the action of neutrons is similar to the action of X-rays. Through the photoelectric and the Compton effects X-rays produce ionization of the material through which they pass, and cause thereby chemical changes and biological effects.

The biological effects of neutrons are qualitatively at least, similar to the action of X-rays. In common with X-rays neutrons produce genetic effects,[1] chromosome abnormalities, inhibitions of mitosis, retardation of growth, and also death of plants, animals, and of carcinoma cells.

While qualitatively the effects of neutrons are similar to those of X-rays the quantitative effects are quite different. The action of neutrons per unit of absorbed energy is in most cases very much greater than the action of X-rays. Moreover the ratio of effectiveness of the two types of radiation differs for different effects or for different materials. For example, the ratio of effectiveness of neutron rays to that of X-rays in the case of mutations of Drosophila is 2:1, in the case of carcinoma it is 6:1, in the case of seedlings it is 5:1 for the successive effects on wheat seeds it is 20:1.

The greater effectiveness of the neutron rays was explained by Zircle and Aebersold[2] and by Failia[3] as being due to the intense fields of the ion pairs created by the passage of a proton through materials. The passage of protons produces an ionization density very much greater than that produced by X-rays, of the order of 100 fold. The concentration of ions may create field of such strength as to affect biological processes. The plausibility of such a view is very great. We must remember that each biological unit, whether a chromosome or a cell, must be conceived of as an entity surrounded by some kind of a boundary or membrane. The exchange of materials between this unit and the surrounding material must take place through this membrane. It is well known that such boundaries or membranes have electrical properties, which influence the passage of matter through them. It is therefore safe to assume that electrical conditions near such membranes may affect it very profoundly and thus exert strong biological influences. The presence of large concentrations of ions near such boundaries are thus likely to produce profound biological effects.

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[1] For a fairly complete bibliography see: L. H. Gray, J. C. Mottram, John Read, and F. G. Spear, "Some Experiments upon the Biological Effects of Fast Neutrons," *The British Journal of Radiology*, Vol. 13 (1940) pp. 155-70.

[2] R. E. Zircle and P. C. Aebersold, "Relative Effects of X-rays and Neutrons," *Proceedings of the National Academy of Sciences*, Vol. 22, (1936) pp. 134-40.

[3] G. Failia, "Biological Effects of Ionizing Radiations," *Journal of Applied Physics*, Vol. 12 (1941) pp. 279-90.

Unfortunately there are flaws with this explanation. If the biological effects are dependent on the density of ionization the effects of X-rays would depend not only on the dosage, but also on the intensity of the X-ray beam. The density of ionization produced by protons or by alpha particles is about 100 times as large as the density of X-rays under certain conditions. It follows, therefore, that if the intensity of the X-ray beam is very greatly increased we may expect a departure from the observed linearity of the effects of X-ray and the dose. Very recently experiments have been performed in our laboratory on the biological effects of a given dose of X-rays as a function of the intensity of radiation, in which the intensity was varied by a factor of 100. No significant variation with intensity was observed. Also, as was stated before, the ratio of effectiveness of the two types of radiation varies with different substances and with different effects exerted by these rays. This suggests that the action of each type of radiation is, in part at least, different in character, and not merely in the degree of ionization. This view is supported by effects of neutrons which have very recently come to light. It has been found that while the neutrons produce the same erythema as an equivalent dose of X-rays, the erythema does not last as long. It has also been found that in the case of inhibition of mytosis of some organism the effect of the neutrone dose increases exponentially, while the curve of the effects of X-rays is sygmoid in character.

It seems that the hypothesis that neutron rays exert their action only through ionization caused by the ejected protons and that the difference in action is due entirely to density of ionization is open to question.

The difference in the action of neutrons and X-rays may be attributed in part at least to the manner of action of the two types of radiation. X-rays exert their action entirely through ejection of electrons and ionization. This is not the case with neutrons. Their action is due mainly to the ejection of protons from molecules containing hydrogen. The removal of a proton is bound to alter the chemical constitution of the molecule, aside from the ionization produced by the passage of the proton through space. The action of the altered molecules may be the cause of the difference in the effects of neutron and of X-rays.

It is estimated that a million volt proton may produce in air some 30,000 ion pairs. It would seem at first glance that the single molecule from which the proton was removed would not exert an action comparable to the 30,000 ions produced by the passage of the proton. The effect of the altered molecules would thus be negligible compared to that of the numerous ions. This, however, is not so. Most neutrons do not make a head-on collision which results in the ejection of a high speed proton. Most neutrons deliver only glancing blows to the protons with which they come in contact since the probability of such an encounter is very much greater than a head-on collision. These glancing blows may result in an ejection of the proton, while the ionization produced by it may be very negligible. Since the loss of energy at each encounter is very small a single neutron may thus affect the constitution of a great number of molecules, while the contribution to the total ionization produced by the protons may not be great. It is clear therefore that the number of altered molecules may be quite appreciable. These altered molecules may produce biological effects and thus account for the difference in the action of neutrons and of X-rays.

AN ATTEMPT AT COMPLETE STATEMENT OF THE THEORY OF NORMAL PRICE

John H. Sherman
Webber College

One of the more widely used among current texts on economics,[1] chosen because typical, opens its discussion of normal price with the passage:

> The conclusion has just been reached that in a competitive market there is an irresistible tendency for market price to be established at the point of equilibruim between demand and supply. But is there any way of telling in advance what this equilibruim price will be? If we may assume a fairly steady demand for a good, is there such a thing as normal price? Market price is the price of the moment conditioned by demand and supply. Normal price is the price that prevails in the long run. Market price is temporary; normal price is relatively more permanent. . . . Market prices may at times be either too high or too low for protracted maintenance at such levels. They are regarded as abnormal. An erratic demand occasioned by the vogue of the moment may force prices up. A temporary local over-supply may force prices down. Competitive market prices over a period of time tend toward a level which is called normal price. From one point of view, normal price is nothing more than the long-time trend of market prices, since market prices are the only real and objective prices. . . . If we may assume a sustaining demand, it is the cost of producing goods which in the long run determines their normal price.

Then follows the now standardized condensation of the theory of Alfred Marshall, under which the competition of entrepreneurs inevitably increases the supply until, by the increase of supply against a continuingly steady demand, market prices are driven down to bulk-line costs of production.

This idea has dominated economic value theorizing for a century and a quarter. David Ricardo in 1817 developed it at considerable length,[2] and John Stuart Mill[3] gave it his sanction in 1848. But it is in the successive editions of Alfred Marshall, from 1890 to his death in 1924, that we find this theory of a normal price made the central and dominating concept of an entire system of economic theory.

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[1] W. H. Kiekhofer, *Economic Principles, Problems and Polcies* (New York: Appleton-Century Co., 1936), p. 486 *et seq.*

[2] David Ricardo, *Principles of Political Economy and Taxation* (any edition), Chapter IV.

[3] John Stuart Mill, *Principles of Political Economy* (Ashley edition; London: Longmans, Green & Co., 1909), p. 478.

Throughout his work Marshall focused attention upon the tendency of prices of stable goods and the accounting costs of their production to approximate to equality "in the long run." His "normal price" was the necessary cost of production and he accounted for it as due to the competition of entrepreneurs in a free market driving the market prices downward until checked by foundation costs of production. These costs were the competitive returns to land, labor, capital and entrepreneurs as rent, wages, interest and wages of management.

His system presupposed by the Ricardian formulae that each of these returns by nature seeks lowest level in a closed competitive system in which the prime factor, management, operates and controls the other factors—the traditional land, labor, capital triology of the English classicists. Pure profits, *i. e.* profits at a rate over and above that necessary as wages of management adequate to hold the normal entrepreneur in the industry,[4] tended to disappear through entrepreneurial competitive reduction of market prices.

He thus created an *a priori* reasoning to project the continuance of that which he had observed, and he carried this on to the field of monopoly prices, where he argued that the tendency to disappearance of pure profits was due to the Monopolist's desire to increase volume for the production advantages of larger-scale operations.[5]

At this point he touches upon the tendency of monopoly to stimulate corresponding monopoly in fact or practice in the supplying of the raw materials needed to be purchased by the monopoly,[6] and in so doing he gets close to the gateway out of his logical difficulties, but being apparently unaware of the difficulties he did not seek the gateway.

These difficulties are three: First, that having defined demand and supply each in terms of amounts to be taken from or released to the market at given successive prices, his conclusions are by logical necessity totally inadequate as expressions of law of cause and effect; second, that he attributes the break-down of the entrepreneur's prime urge to a short-sighted scramble for immediate profits among the class which he[7] describes with great emphasis as the most intelligent and far-seeing group; and third, that the goods which fill a demand of the long-time stability assumed in his theory, go into a market in which the gross volume demanded is steadily increasing at a rate approximately commensurate to the growth of population, so that the underlying tendency of the market is upward.

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[4] Alfred Marshall, *Principles of Political Economy* (8th ed.: London: Macmillan, 1938), Books IV and VI.

[5] *Ibid.,* Book V. Chap. 14.

[6] *Ibid.,* Section 9, p. 493.

[7] *Ibid.,* pp. 297-313

The purpose of this inquiry is to ascertain the reasons for the long-time approximation of market prices to bulkline costs and the observed tendency to disappearance of pure profits, by a reasoning which shall avoid the use of Marshall's fallacies and shall include the factors which he omitted.

* * * * *

The entrepreneur, possessing intelligence and foresight, launches a new enterprise or enlarges an old one only after satisfying himself that the market price prevailing after the advent of his product will be sufficient to cover all necessary costs of functions which must be performed in the productive process. There are six such functions, each performed by an appropriate factor, necessary in any production, regardless of the size of operation or the number of individuals involved in it. These are:

1. *Spacing*, or room provision. Every productive activity must utilize land area to the exclusion of other uses. Whether this land area be privately or publicly held is immaterial. In any case its use for one process excludes its use for some other which is dispensed with, or conducted at increased disadvantage elsewhere. The function must always be performed by somebody, and is an inevitable cost in any production. This cost is called rent, and exists whether covered by accounting process or not. It is a bargained share.

2. *Working*, or the moving of things. The objective physical aspect of every productive enterprise is the same: man moves external things into certain juxtaposition and forces of nature operate upon them to cause growth, destruction, adhesion, repulsion, expansion, condensation, stability, regularity or eccentricity of subsequent movement, as the human desire may be. This moving of things is onerous and usually unpleasant. It can be secured only at expense of goods for inducement (usually money) or of alternative activities foregone, and is a necessary cost in any production, called wages. It exists whether covered by accounting process or not. It is a bargained share.

3. *Waiting*, or lending. It takes time to move things; natural processes require time; and most productive processes require successions of such movings and processings. Those human beings who engage in productive activity, therefore, always have a period of delay between the time of their functioning and the moment of return. In civilized practice those who do the moving usually have need for im-

mediate sustenance prior to the distribution of the product, and a class of specialists arises to perform this waiting. They advance money for wages, purchase of tools, and other costs necessary to be incurred in anticipation of product, in consideration of a contracted share in the final dividend. This money or goods advanced by specialized waiters in aid of projected production is capital; its contracted return, interest. Such waiting is inherently necessary in all production, whether performed by a specialized class and covered by accounting process or not. It is always present and is a true cost: a bargained share.

4. *Risking,* or undertaking. Just as, objectively, man does only one thing through life, moving things; so subjectively he does only one thing. He makes decisions. All mental activities—, thinking, hoping, remembering, planning,—are but steps in the process of deciding what to do next. Most men are subject to confusions of thinking such as to force them frequently to indecision or paralysis of action, yet are under economic compulsion to act. They become followers of those having capacity for prompt decision. The decisions thus delegated by the masses of men are of two classes: those involving primarily a choice of what to do, and those involving primarily a choice of how to do it. Decisions what to do or undertake are primarily decisions of assumption of risk: speculative decisions, essentially philosophical in character, forecasts of future conditions exterior to the productive enterprise itself—usually of markets for product or of changing sources of supply of factors to be combined in the enterprise. This risking, or entrepreneurship, is a necessary function even in a one-man industry. It requires time, attention, and energies diverted from other productive activities. It is a true cost, usually not so considered in the accounting, and is undertaken by the entrepreneur in an effort to secure a residue of pure unbargained profit after paying contracted returns to each of the other factors, and to himself whatever amount is in fact necessary as a bargained share to hold him in risking as against his next most attractive form of functioning. It is this pure profit which all economists agree tends to disappear in the long run.

5. *Managing,* or planned combining of factors. Just as decisions what to do are primarily decisions of assumption of risk, speculative, philosophical in character, and concerned with future exterior conditions; so decisions of how to do it are primarily decisions of technique, nonspeculative, scientific in character, and concerned with present or currently evolving interior conditions of the productive organization. Such decisions, controlling the working, waiting, spacing, etc., are

the function of the manager. Managing is done always to the exclusion of other activities and at sacrifice to the factor. It is a necessary cost, present whether covered by accounting process or not. Its return, in form of salary or salary-equivalent, is a bargained share.

6. *Seeing fair,* or guarding the competitive interests. The income to the enterprise and also the return to each of the bargained factors as well as the sure retention of any surplus which may result to the entrepreneur for his risking, are technically determined and designated by contracts. The maintenance of fair play between the parties to the negotiation of these contracts and the guarding of those interests as they materialize, form a necessary function without which no stable productive enterprise, and no safe market, would be possible. This function is performed by government in the interest of the whole society. Where formal contract has not been made, government constructs by legal process a contract which is in compliance with the custom of the industry, and enforces that. In the performance of this function of seeing fair, government sets limits to the type of bargaining which may be used and also determines the kind of bargain which may be sought to be enforced in the dealings and relationships between the factors as well as between the industry and the outside buying public. The reward of government is taxes—a bargained share, especially observable to be such in democracies and clearly so recognized by sociologists, political scientists, and practical politicians.

* * * * *

The industrial picture then, in even the most simple of human societies is that of a few men making decisions of risk, in pursuance of which decisions of management are made and workers follow these decisions of management in moving things around on space provided at sacrifice of other uses, while specialized waiters furnish needed equipment for operations and for sustenance of all these factors under guard and control of a supervising government.

What happens then upon the successful establishment of a new industry or an enlargement of the old?

Upon the appearance of the net return or pure profit, with resultant prosperity of enterprise and enterpreneur, six tendencies at once come into play:

1. Rents increase. On this Ricardo's analysis and explanation are still satisfying.[8]

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[8] David Ricardo, *Political Economy and Taxation* (any edition), Chap. 2.

2. Labor, always restless under the appearance of successful exploitation, sees the large profit and demands more wages. This demand is insatiable so long as the margin remains visible or known. If evaded by "betterments" these are costs. If resisted openly, this means reduced efficiency, increased labor turnover, and increased costs for superintendence. On principle laborers quite generally resent any organization in which they believe profits unduly large. This feeling, and considerations of groupal loyalty operate to prevent laborers on the outside from competing by underbidding for the job of the laborer who is well paid or striking for more pay. The "scab" is the exception among laborers. The appearance of pure profits thus increases the demands of labor and reduces competition within the ranks of labor. Wages rise.

3. Investors and financiers who see a large gross profit, and know or suspect a part of it to be pure profit, take advantage of every crisis and every need, to secure for themselves a larger share in the returns of the enterprise. This they accomplish by the conditioning of loans upon the maintenance of other trade relationships such as raw material purchases, with other concerns in which the financiers are interested. Thus the total percentage costs incident to the waiting function are increased.

4. Lawyers' and consultants' fees, expert services of every kind, and managers' salaries all increase sharply as profitability becomes evident. With the passage of time the services of the individual consultants and managers become increasingly essential to smooth operation. Overhead systems multiply. Distributors and salesmen secure personal control over trade territories and strike for more discount, increased commissions, or increased salaries and expense allowances. The entrepreneur's costs for management all increase.

5. Taxes, license fees, franchise renewal costs, etc., all increase in amount. Whether they increase in amount per unit of product may depend upon conditions of the specific time, jurisdiction, and product, but since in general the effort of the state is to place these burdens where experience demonstrates that they can be borne—*i. e.* on profits and profitability in gross amount—there tends to be an increase in the unit cost.

6. Pure profits shrink—through the competition of productive factors within the industry, which drives costs up toward whatever

happens to have been the original market price, whether that price was initially set by competition, by custom, or by governmental fiat and monopoly control, as in the case of tariff-created infant industries.

* * * * *

In the face of these practical considerations, what likelihood is there that new entrepreneurs will enter to force sales prices down?

A very few may. They will be little fellows of the kind having from the start insufficient advice and inadequate banking. The entrepreneur who is to enter with adequate financing quickly finds that his investors advancing permanent capital and his bankers furnishing short term credit for current operations must be convinced that taxes, license fees, franchise costs; rents and all location costs; interest, commissions and other costs of financing; wages, "betterments," insurance and other costs of labor; and wages of management, salaries, retainer fees and other expenses of control, all are stable; that there exists a comfortable margin of safety above these; and that the market is sufficient to support current prices for the increased product within the immediately visible future.

These investors and bankers are both the best informed and most conservative elements in the whole industrial society. They also are a relatively small group, inclined to be mutually protective as against other interests. The plan and prospects of the entrepreneur must pass the scrutiny of this most conservative group of critics before he can proceed. It would appear probable therefore that entrepreneurial competition is the least likely of all possible forces to destroy pure profits.

The existence of counterbalancing tendencies is not denied, especially during short periods of falling prices and declining volume of business, but it is probable that over the average of long periods the above described tendencies prevail so long as the secular trend of prices is upward.

Over short cycles these tendencies are practically unchecked during periods of rising prices; while during periods of falling prices a multitude of social and governmental forces centering around the effort to hold any improvements that may have been secured for the masses, enter to protect them from complete counterbalance or reversal.

Viewing the problem from the points of view of industry as a whole, the single industry, and the single plant: it will be found that in industry as a whole the above statement needs no modification. In the single industry taxes, rents, and management will show all these upward tendencies at their full; while wages and costs of financing will have upward tendencies, retarded only insofar as competitive forces may prevent their more fluid factors from showing such marked difference from immediately surrounding industries as in the case of taxes and rents.

The same observations will apply to the single plant. The tendencies are all there, even though in any given instance one, or other, or all, may happen at the moment to be counterbalanced. A case in which all are counterbalanced momentarily would be exceptional. A case in which all are counterbalanced permanently for the long run probably would be impossible.

NEOTENY IN FLORIDA SALAMANDERS

A. F. CARR, JR. AND COLEMAN J. GOIN
University of Florida

The tendency to attain sexual maturity as a gilled larva is exhibited with unusual frequency by many of the races of the tiger salamander (*Ambystoma tigrinum*), a species which is distributed practically throughout the United States. As a transformed adult *tigrinum* is a terrestrial, somewhat fossorial salamander with a tendency to wander some distance from water and to subject itself to surprisingly high evaporation rates. In Florida we have taken it as far as a quarter of a mile from any permanent water, usually in sandy, well drained soil in upland hammocks or fields. In certain parts of its range it is found regularly as a permanent larva, while in other sections only an occasional small colony of such individuals is encountered. A recent paper by Dunn[1] on the races of *tigrinum* gives some information on the distribution of neoteny in the complex. This may be summarized as follows:

Race of *A. tigrinum*	General Distribution	Occurrence of Neoteny
tigrinum	Long Island to northern Florida to Minnesota to Missouri	in one Florida specimen
velasci	Mexican Plateau	frequent
mavortium	Kansas and Colorado southward through western Texas and central New Mexico	occasional
diaboli	North Dakota and adjacent parts of Canada	not infrequent
slateri	Northwestern United States and western Canada	not infrequent

The condition is also demonstrated by the species of *Siredon*, a genus recently resurrected for the Ambystoma-like forms which are characteristically, if not invariably, perennibranch.

Neoteny is, thus, a condition found almost exclusively among the western representatives of the group. The problem of explaining the occurrence of these sexually mature larvae, or axolotls, has stimulated considerable inquiry by experimental physiologists, who have greatly augmented our understanding of hormonal action in the metamorphosis of the Amphibia but who have yet to explain the regional distribution of the axolotl.

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[1] Emmett Reid Dunn, "The Races of *Ambystoma tigrinum*," *Copeia*, 1940, No. 3, pp. 154-162.

It is well known that the thyroid gland, a potent influence in mammalian metabolism and development, is a principal agent in amphibian metamorphosis. Various investigators have shown that thyroid abnormalities, due either to chemical or physical maladjustments (such as a lack of iodine in the water or extremely low temperatures) or to hereditary factors, may be responsible for the phenomenon of neoteny. In this connection it is of interest to note a considerable distributional overlapping between the higher incidences of goiter in man and of neoteny in *Ambystoma*.

The only published record of neotenic tendencies in the Ambystomidae of Florida is that of Dunn[2] for a single specimen (USNM 14682) of *Ambystoma t. tigrinum* from Micanopy, Florida. This is a large larva, in a poor state of preservation, with head-body length of 110 mm, tail length of 92 mm, and with apparently 12 costal grooves.

While collecting for the Carnegie Museum in January, 1935, Dr. Wesley Clanton obtained thirteen neotenous *talpoideum*, seven gravid females and six males, from a small woodland pond near Hale's Siding, Paynes Prairie, Alachua Co., Florida. In this series, which shows considerable variation in the degree of retention of larval characters, the characteristic sexual swellings are as well developed as in completely metamorphosed adults from the same locality. Wide variation is also exhibited in the extent of the dorsal fin. In those specimens which have retained the gill filaments the fin reaches the region above the gills, while in those with reduced gills it extends only to the region above the hind legs. All of the specimens are brownish-gray above with numerous small, round, black spots. The ventral pattern is striking, being consistently comprised of a spindle-shaped median black stripe enclosed by two curving, cream-colored bands. These latter are in turn bordered by poorly defined light gray stripes which separate them from a second pair of ventro-lateral light cream-colored bands.

We have recently located a population of a neotenous ambystomid salamander in a small pond about seven miles northeast of Marianna, Jackson Co., Florida. Although we do not feel it advisable at present to propose a new name for this curious creature we are unable to assign it to any form known to us. In the presence of two plantar and two palmar tubercles and 11 costal grooves it agrees with *A. t. tigrinum* and *A. talpoideum* but not with *A. maculatum* or *A. opacum*. In general appearance and coloration it seems most like larval *tigrinum*, but *tigrinum* has from sixteen to twenty gill rakers (the Micanopy specimen has twenty) whereas our specimens have only eight. This is also the count for *talpoideum*, but the Jackson County specimens are readily distinguished from the neotenic *talpoideum* mentioned above by the more spatulate head, the more pendulous upper lip, the less prominent eyelids, a more pronounced dorsal keel, and a thicker, heavier body. In all of our specimens the posterior edge of the gular fold forms a broadly obtuse, anteriorly directed angle, rather than a smooth curve as in *talpoideum*. When collected, these salamanders were a pale pea-green above and light below. Since preservation they have become dark gray dorsally and dirty white below, with numerous flecks of dark gray on a line between the front and hind legs and on the venter, leaving a narrow immaculate band between the two regions of flecking. Neotenous *talpoideum* tend to be brown rather than gray with much heavier pigmentation, usually in the form of longitutinal stripes, on the venter.

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[2] *Op. cit.*, p. 156.

Examination of these specimens shows them to be strikingly similar in general build and coloration to the Mexican axolotl, *Siredon mexicanum* Shaw. However, the latter has about twice as many gill rakers as our specimens, is somewhat heavier in build and is lighter gray in coloration. In none of our specimens is the tail fin as strongly developed as in the *Siredon* we have examined.

Our only field acquaintance with the Mexican axolotl was gained on a recent collecting trip, when a flourishing colony was found in a series of shallow ponds southeast of the city of Puebla (kilometer 224 from Mexico, D. F.) Half a dozen seine hauls in this unpromising situation yielded more than a hundred specimens of *Siredon*. Although the arid terrain of the Mexican Plateau is scarcely comparable to the rolling, pine-clad hills of the Marianna lowlands, striking similarities in the ponds themselves were noted. In both instances they were turbid, clay-bottomed, and fed by local drainage. A paucity of hydrophytic vegetation, except microscopic algae, appeared to indicate extreme seasonal fluctuation with probable occasional disappearance of all water. In both places the fauna was poor in variety. In the Mexican pond a kinosternid turtle was the only other vertebrate found, while at Marianna the vertebrate associates of the axolotls were tadpoles of *Rana catesbeiana*, a few softshelled turtles (*Amyda rerox*) and newts (*Triturus v. lousianensis*). In both situations the most abundant invertebrate was a species of water boatman (*Corixidae*) and in each instance this form appeared to be the staple food of the axolotls. To emphasize further what may be a purely coincidental agreement in physiognomy, a beetle taken in the Marianna pond and brought to Mr. Frank N. Young for identification was found to be *Eretes sticticus* (L.), a form hitherto known in the United States only from Arizona to Kansas, but which is widely distributed in Mexico.

What appears to us as perhaps the most significant of the several points of agreement in the two habitats is the lack of logs, stones, or other debris around the water's edge and the generally unprepossessing aspect of the surrounding territory. Having observed adult ambystomas only as burrowers in loose, friable soils or as occupants of chambers hollowed out beneath objects lying on the surface of the ground, we were unable to see how either of the colonies of axolotls could have prospered as metamorphosed, air-breathing adults. The abandonment of larval existence in the comparatively benign aquatic environment to take up a new kind of life on land must at best be a critical and hazardous step for an amphibian. In the case of the axolotls such a project would appear foredoomed to disaster.

As was implied above, axolotls are found most frequently in either very arid regions or at high altitudes, where the disparity in terrestrial and aquatic ecological factors is emphasized. It is thus necessary to consider the possibility that neoteny in certain cases may be an adaptive response rather than a mere endocrine aberration due to chemical deficiency or to fortuitous gene changes. Accordingly, it seems reasonable to believe than in what appear to be homogeneous colonies of permanent larvae, certain individuals may from time to time undergo metamorphosis only to dessicate or starve in a hostile environment, while those showing a hereditary tendency toward hormone deficiency survive and become gradually the predominant strain.

LITTORAL FAUNA OF THE MIAMI AREA.
I THE MADREPORAPIA*

F. G. Walton Smith
University of Miami

The need for comprehensive accounts of the littoral fauna of southeastern Florida is greatly emphasized by the incomplete and scattered nature of the nevertheless numerous earlier reports. In 1928, however, Pearson (1936) by the introduction of the diving helmet as a regular feature of classes in marine zoology made possible the development of accurate underwater surveys of the waters south of Miami. During the course of over ten years these have resulted in the collection of considerable data and have made it possible to begin detailed ecological studies of the area. As a preliminary to these studies it is necessary to fill the gaps left by earlier workers and to list the organisms commonly occuring together with such notes as to numbers, habitat and breeding habits as are available.

For the past few years, since the closing of the Dry Tortugas laboratory of the Carnegie Institute of Washington, facilities for the study of tropical shore and reef organisms and the many fundamental problems centered around them have been very limited in the United States. It is believed, however, that the present series of reports, resulting from the study of an area now made accessible, may facilitate such investigations on the shores and reefs within working distance of the Miami stations. Insofar as possible an attempt is being made to list all the animals so far known in each of the principal groups, together with ecological notes and keys for their identification in cases where these are not already available.

Some of the earliest general descriptions of the Florida reefs are those of Pourtales (1880), Agassiz (1882, 1888, 1894) and Dana (1890). Incomplete lists of the corals forming these reefs are to be found in the publications of Pourtales (1870) and Duncan (1884). For more detailed lists of the corals, however, it is necessary to consult the papers of Vaughan (1900 b), Verrill (1902 a), and Duerden

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*Awarded Achievement Medal for 1942.

(1902). Verrill gives particularly good descriptions and figures of most of the species, while Vaughan provides an account of the Puerto Rico corals. Since the fauna of the West Indies and Southern Florida are in many ways similar, Vaughan's discussion of the Puerto Rican species applies equally to the Miami area. Descriptions of the "brain-corals" and other meandriform corals in the more recent work of Matthai (1928) are detailed and comprehensive. His descriptions and illustrations together with those of Vaughan and Verill cover all the species known to Florida.

Ecological observations, particularly those regarding the effects of exposure to varying conditions of sunlight, temperature, salinity and sedimentation, are contained in a series of reports in the Carnegie Institute Year Books (Vaughan 1908-15) and are summarized in a later paper by the same author (1916). The same sources include brief notes on the breeding habits and figures for the growth rates of Florida corals.

A large memoir revising the classification and nomenclature of the Hexacoralla, by Dr. T. Wayland Vaughan and Dr. John W. Wells, is in the course of publication. This contains a detailed account of the structure of the polyp and skeleton and includes a chapter on the ecology of corals.

The present account lists all the reef and inshore corals taken in the area and is based upon the collections of the Zoology Department of the University of Miami. They are representative of about one hundred and fifty charted stations between Carysfort Reef and Fowey Rocks. Identified specimens of each species and of some doubtful sub-species and varieties have been deposited in the Marine Museum of that institution. The nomenclature employed here has been adapted primarily to facilitate reference by the non-taxonomic worker to the more recent accounts cited, and is not necessarily accepted by all contemporary systematists. Most species have been taken on at least one occasion in the Miami area, although some, shown in brackets, have been recorded only from the Tortugas or West Indian shores. The list is limited to inshore forms found in less than 10 fathoms.

For the identification of some of the corals and for valuable advice I am indebted to Dr. T. Wayland Vaughan of the Smithsonian Institution. Acknowledgments are also due to Dr. Jay F. W. Pearson and others who have during the past ten years collected the large amount of material upon which this report is based.

KEY TO THE MADREPORARIA

1. Corallum porous and loosely constructed. Septa not more than twelve....(2)
   Corallum not porous. Septa numerous ....(8)

2. Small cylindrical calices projecting and separate from each other. Large branching colony ....(3)
   Calices shallow and continuous, not projecting. Small branching or massive colony ....(5)

3. Branches palmate or fan-like. *Acropora palmata* (*Lamarck*)
   Branches cylindrical ....(4)

4. Branches crowded, anastomosing and fused. *Acropora prolifera* (*Lamarck*).
   Branches not anastomosing but diffuse. *Acropora cervicornis* (*Lamarck*).

5. Colonies massive, lobulate. Pali usually absent. Calices usually about 1.5 mm. in diameter. *Porites astreoides Lamarck.*
   Colonies branched. Five or six pali........................(6)

6. Branches with blunt swollen ends. Calices shallow and about 2 mm. in diameter. Columella usually with tubercle above. *Porites clavaria Lamarck.*
   More slender branches, tips not swollen. Columella without tubercle. ....(7)

7. Calices 1.5 mm. in diameter; stems usually more than 6 mm. in diameter. *Porites furcata Lamarck.*
   Calices 2 mm. in diameter; stems less than 6 mm. in diameter. *Porites divaricata Le Sueur.*

8. Lamellate septa with synapticulae; calices closely placed but not confluent. No definite walls. ....(9)
   Synapticulae usually absent. Definite walls to calices. ....(12)

9. Colonies massive. ....(10)
   Colonies usually foliaceous. ....(11)

10. Upper edges of septa between calices flattened, inner margin vertical. Calices irregular in shape, 2.5 to 3.0 mm. across. *Siderastrea radians* (*Pallas*).
    Upper edge of septa subacute, inner margin sloping to bottom of calice. Calices subhexagonal and about 4.5 mm. in diameter. *Siderastrea siderea...* (*Ellis and Solander*).

11. Typically foliaceous colonies. Ridges separate calices into more or less parallel rows. *Agaricia agaricites* (*Linne*).
    Growth more massive than foliaceous. Ridges irregularly disposed. *Agarica agaricites. var. crassa Verrill.*

12. Branching colonies. Well separated calices. ....(13)
Massive colonies. Calices not widely separated. ....(16)

13. Branches less than 10 mm. in diameter. ....(15)
Branches more than 10 mm. in diameter, short and thick. ....(14)

14. Columellar centres distinct; septa up to 8 per cm., margins much toothed; walls 6-8 mm. thick. (*Mussa angulosa* (*Pallas*)).

Columellar centres not marked; septa up to 18 per cm., margins entire; walls 2 mm. thick. *Eusmilia fastigiata* (*Pallas*). *includes E. Knorri M. Edwards and Haine and E. aspera* (*Dana*).

15. Corallite rim projects only slightly above coenenchyma. *Oculina diffusa Lamarck.*
Elongate tubular calices project prominently. *Cladocora arbuscula Le Sueur.*

16. Corallites not confluent. ....(17)
Corallites confluent. ....(22)

17. Corallites contiguous. ....(18)
Corallites in less close contact, oval or rounded........(19)

18. Corallites eliptical or hexagonal, simple; septal margins not coarsely toothed. *Favia fragum* (*Esper*)
Corallites rather polygonal, compound. Collines grooved or ridges. Septal margins coarsely toothed. (*Isophyllastrea rigida* (*Dana*).

19. Corallites oval in shape. Colonies dome shaped. *Dichocoenia stokesi Milne Edwards and Haime.*
Corallites rounded. ....(20)

20. Costae do not extend between calices. *Solenastrea hyades* (*Dana*).
Costae extend between calices. ....(21)

21. Calices up to 8 mm. in diameter; 48 septa. *Montastrea cavernosa* (*Linne*).
Calices about 3 mm. in diameter; 24 septa. *Montastrea annularis* (*Ellis and Solander*).

22. Valleys radiating or relatively short and wide. Colony usually small, often attached by stalk. ....(23)
Valleys labyrinthiform. Colony large and heavy. ....(27)

23. Septa and teeth thin, many. ....(24)
Septa and teeth coarse, few........(25)

24. Corallum vesicular, large. Columella absent. Septa about 10 per cm., converging. Valleys wider and deeper than above. (*Colpophyllia natans* (*Muller*)).

25. Sub-turbinate, elongate. Columellar centres connected by lamellae. Valleys about 15 mm. wide at edge of corallum. (*Mycetophyllia lamarckiana.*) (*Milne Edwards and Haime*).
Flat-convex. Columellar centres connected by trabeculae. Valleys near edge 20-30 mm. wide. ....(26)

26. Valleys 14 mm. wide, 20 mm. at edge of corallum. Septa 11-12 (*Isophyllia multiflora Verrill*).
    Valleys 22 mm. wide, 35 mm. at edge of corallum. Septa 7-9 per cm. *Isophyllia sinuosa* (*Ellis and Solander*) = *I dispacea* (*Dana*).

27. Edges of septa dentate, columella trabecular, narrow valleys.....................(28)
    Edges of septa entire, columella lamellar or solid.......................................(30)

28. Collines with well defined ambulacra. *Diploria labyrinthiformis Linne.*
    Collines without well defined ambulacra. ....(29)

29. Corallum hemispherical, surface evenly convex. (*Diploria strigosa* (*Dana*).
    Corallum flat. Surface uneven and nodular. *Diploria clivosa* (*Ellis* & *Solander*).

30. Cylindrical branches arising from massive base. Valleys less than 6 mm. wide, collines 6 mm. Septa relatively thick. *Dendrogyra cylindrus Ehrenberg.*
    Massive, without branches or nodules. Valleys up to 20 mm. wide. Large septa. ....(31)

31. Large, massive. Valley discontinuous, usually about 10-12 mm. wide. *Meandrina meandrites* (*Linne*).
    Smaller, turbinate, with short penducle. Valley continuous longitudinal portion with lateral branches 15-20 mm. wide. *Meandrina brasiliensis Milne Edwards* & *Haime.*

The distribution of corals is dependent upon several important factors, the action of which has been investigated by Vaughan in the case of Florida species. The temperature of Miami waters is near the lower limit (Vaughan 1916) so that vigorous reef formations do not occur north of the Eliott Key area. Only a few scattered coral heads and some of the shallow water species are to b efound sparsely distributed in the waters immediately north of Fowey Rocks.

In the reef zone itself, characterized by strong wave action, relatively little sedimentation, absence of atmospheric exposure and relatively small temperature range are found the massive forms, firmly attached to the bottom and able to withstand the mechanical strain of wave action. The only branching form characteristically occurring here is *Acropora palmata,* one of the most important reef builders, enabled to withstand reef conditions by virtue of its strong branches. Other corals characteristic of this zone are *Diploria strigosa, Diploria labyrinthiformis* and *Montastrea annularis.* Rather less plentiful are *Diploria clivosa, Montastrea cavernosa* and *Solenastres hyades. Dicho-*

coenia stokesi and *Porites astreoides* are also present, though not forming such large masses as those previously mentioned. *Porites clavaria,* forming stumpy, branching masses is common to the leeward side of the reef, with *Agaricia agaricites, Favia fragrum* and *Siderastrea siderea* present to a lesser degree. Further removed from the seaward edge of the reef is *Acropora cervicornis*, which seems to grade into *Acropora palmata* by way of *Acropora prolifera,* with increasing exposure to the mechanical effects of wave action. A discussion of the validity of these species is out of place here but has been covered by Vaughan (1900).

The extension of the reef seaward is limited by depth and possibly by the associated diminishing plankton content and wave action, together with increasing sedimentation.

At the opposite extreme of the environmental range, along the eastern shores of the Keys and on the exposed flats corresponding to Pearson's zones 1 and 2, occur corals able to withstand periodical exposure to the atmosphere, occasional high temperature and heavy sedimentation. These are principally *Porites furcata*, *Manicina areolata* and *Siderastrea radians.* Between the two extremes is a considerable amount of overlapping, especially in the case of the hardy *Porites clavaria*, which is common throughout all zones, being more stumpy where exposed to strong wave action, and more slender on the shallow flats and shores. *Manicina areolata* is another hardy species found wherever wave action is not strong enough to wash it from its hold or to overturn it. It is particularly useful for physiological experiments because of the large polyp and the ease with which it may be kept alive in aquaria, using small fish and crustacea for food.

The massive corals of large growth form do not extend inward from the reef zone, probably because of their lack of ability to withstand sedimentation. This is not so noticeable in the case of branching forms other than *Acropora* species. The less common *Oculina diffusa, Cladocora arbuscula* and *Eusmilia fastigiata* (E. aspera), found on the less exposed parts of the reef are also found in the intermediate zones where water currents prevent sedimentation but where there is not exposure to heavy wave action. Others occurring less frequently are *Dendrogyra cylindrus*, found only on the exposed outer reef, *Mean-*

drina meandrites, a massive reef form, and *Isophyllia sinuosa* (I. dipsaceae) in the less exposed zones of the inner reefs and flats.

Growth rates of some of the forms above mentioned have been measured by Vaughan (1916). It appears that the greatest mass increase occurs in the branching *Acropora palmata* which may during the course of a year grow in height as much as 3.5 cm. and in spread considerably more. The massive forms, such as *Montastrea annularis*, do not increase vertically more than 7 mm. per annum.

So far planulae have been found only in the early months of summer, between the beginning of May and July, but it is by no means certain that breeding is restricted to these periods. Very little has been published with regard to coral larvae and it is accordingly difficult to distinguish them. It is hoped that more information on this subject may be collected from future studies in the Miami area.

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TWO NEW CRAYFISHES FROM THE PANHANDLE OF FLORIDA

(Decapoda, Astacidae)

HORTON H. HOBBS, JR.
University of Florida

The two new crayfishes herein described represent the two most common crayfishes occurring in the panhandle of Florida. *Procambarus leonensis* occupies numerous habitats in the area between the Suwannee and the Apalachicola rivers, and *Procambarus pycnogonopodus*, also decidedly ubiquitous, is restricted to an area between the Apalachicola River and a well-drained region in Walton and Holmes counties. While both of these species occur in a wide variety of habitats, they are more abundant in lenitic or sluggish lotic situations.

Procambarus leonensis sp. nov.

Figs. 1, 6, 7, 10, 12, 13, 14, 16, 17, 22, 26, 29, 31.

Diagnosis.—Rostrum with small lateral spines or tubercules, areola moderately broad with two rows of punctations, hooks on ischipodites of third and fourth pereiopods in the male; first pleopod of first form male bearing all five processes, caudal process vestigial, mesial and cephalic processes subspiculiform, cephalic process not distinctly recurved, distal portion of appendage directed caudo-ventrad.

Holotypic Male, Form I.—Body subcylindrical, slightly compressed laterally. Abdomen narrower than thorax (1.92-2.14 cm. in widest parts respectively).

Width and depth of carapace subequal in region of caudo-dorsal margin of cervical groove. Greatest width of carapace slightly caudad of caudo-dorsal margin of cervical groove.

Areola of moderate width (7.14 times longer than wide); with two rows of punctations in its narrowest part; sides parallel for a short distance in middle. Cephalic section of carapace about 1.9 times as long as areola (length of areola 33.8% of entire length of carapace).

Rostrum excavate, reaching base of distal segment of peduncle of antennule; margins converging (with only a slight break at the base of the acumen) to tip forming a sharp spine. Acumen set off rather indistinctly by two small rounded tubercles at its base. Upper surface of rostrum polished; ridges on sides not swollen. Tip of acumen not

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[1]Contribution from the Department of Biology, University of Florida.

upturned. Subrostral ridges well defined but obscured in dorsal aspect by the upper part of rostrum.

Postorbital ridges well defined, terminating cephalad in small rounded tubercles. Suborbital angles obtuse, weak. Branchiostegal spines well developed. A well-defined tuberculiform lateral spine present on side of carapace, subtended by a few smaller tubercles. Surface of carapace punctate dorsad, granulate laterad.

Abdomen longer than thorax (4.84-4.65 cm.).

Anterior section of telson with four spines in the right postero-lateral corner and three in the left.

Epistome (Fig. 29) isosceles-trapezoidal in shape with a distinct, strong medium spine on the mid-cephalic border.

Antennule of usual form; a spine present on the ventro-mesial side of basal segment.

Antenna reaching caudad to cephalic margin of telson. Antennal scale broad (broadest slightly proximad of middle), extending to tip of peduncle of antennule; spine on outer margin strong.

Chela (Fig. 22) subovate, compressed dorso-ventrally, long and slender; tip of dactyl passing below tip of propodus when fingers are brought together. Hand entirely tuberculate. Inner margin of palm of right chela with one row of ten tubercles subtended both above and below by smaller scattered tubercles. A distinct ridge present on both fingers. Fingers not gaping.

Mesial margin of movable finger concave mesiad with a row of nine distinct tubercles on proximal two-thirds; distal third with a row of punctations. Proximal third of finger with tubercles both above and below; distal two-thirds punctate. Proximal half of lateral margin with a row of twelve tubercles; numbering from base of finger, the sixth through the ninth are larger. A linear series of four widely spaced tubercles subtending this row above. Crowded denticles along the whole length of lateral margin.

Immovable finger with crowded denticles along whole length of mesial margin. Nine knob-like tubercles, of which the third from base is largest, lie along proximal half of mesial margin. One very conspicuous, acute tubercle extends from ventro-mesial margin slightly distad of mid-length. Proximal half of outer margin of finger with a row of small tubercles which give away to punctations along distal half.

Carpus longer than wide (1.35-.76 cm.); shorter than inner margin of palm of chela (1.73 cm.); a distinct longitudinal groove above; dorso-mesial, mesial and ventro-mesial surfaces tuberculate, otherwise punctate. Three well defined spines on mesial surface: one on dorsal cephalo-mesial margin, one on mesial surface, and the other on ventral cephalo-mesial margin.

Merus punctate on lateral and proximo-mesial surfaces, distal portion of mesial surface with a few scattered tubercles. Upper surface tuberculate with two spines on upper distal portion. Lower surface with two rows of spike-like tubercules: a well defined inner row of 15, and a less well defined row of 16, subtended on both sides by other smaller tubercles.

Hooks present on ischiopodites of third and fourth pereiopods. Basiopodite of fourth pereiopod with a weak tubercle directed toward hook on ischiopodite.

First pleopod (Figs. 1, 6, 13) reaching to base of third pereiopods; terminal portion of appendage (outer part) with a heavy tuft of setae which completely obscures all terminal processes except the mesial. Appendage terminating in four distinct parts. The mesial subspiculiform process extends from the mesial side of the appendage in a distal caudo-lateral direction. The cephalic process, also subspiculiform, extends from the cephalic portion of the tip in a caudo-lateral direction. The central projection, composed of two parts, is a small corneous, subspatulate structure extending from the center of the outer part of the appendage; the centro-cephalic process is the larger of the two elements. The caudal process is vestigial, slightly curved, and lies at the base of the centro-caudal process of the central projection.

Male Form II.—Differs from male, form I, in the following respects: Rostrum with small lateral spines at base of acumen. Postorbital ridges terminate cephalad in small spines. Lateral spines distinctly spiniform. Anterior section of telson with three spines in each postero-lateral corner. Antenna reaching to end of telson. First pereiopod weaker than in first form male, but essentially similar. Hooks on the ischiopodites of third and fourth pereiopods reduced to tubercles. First pleopod with same number of terminals, all of which are reduced, and non-corneous.

Female Allotype.—The only appreciable difference in the female and the first form male is that the chela is smaller in proportion and apparently weaker.

Annulus ventralis (Plate I, fig. 9) subtriangular; caudal margin symmetrically bilobed. Sinus originating along midventral line near cephalic margin, extends gently caudo-sinistrad, then caudo-dextrad to the midventral line and finally caudad almost to the caudal margin of the annulus, terminating on the caudal surface of a small mound.

Measurements.—Male (Form I) Holotype: carapace, height 2.15, width 2.15, length 4.65 cm.; areola, width .22, length 1.57 cm.; rostrum, width .73, length 1.28 cm.; abdomen, length 4.84 cm.; right chela, length of inner margin of palm 1.73, width of palm 1.29, length of outer margin of hand 4.52, length of movable finger, 2.56 cm. Female Allotype: carapace, height 1.82, width 1.95, length 4.14 cm.; areola, width .26, length 1.26 cm.; rostrum, width .72, length 1.29 cm.; abdomen, length 4.73 cm.; (right chela, broken) left chela, length of inner margin of palm 1.14, width of palm .95, length of outer margin of hand 2.99, length of movable finger 1.74.

Type Locality.—A sinkhole pond 3 miles southwest of Tallahassee, State Highway 19, Leon County, Florida. It is unfortunate that this pond is adjacent to the large Army airport now being developed, and it may be entirely filled in the construction work now going on. This was chosen as the type locality because the best specimens and the largest series of *leonensis* in my collection were taken from this pond. At the time the collections were made, the pond was drying up, and the crayfish were dug from burrows ranging from one and one-half to two and one-half feet deep. The burrows were for the most part simple, that is, one straight or sloping passage downward to the water table. The soil was black plastic mud.

Range and Habits.—This species occupies a relatively large range in the state, having been recorded from the following counties: Franklin, Jefferson, Lafayette, Leon, Liberty, Madison and Taylor. *Procambarus leonensis* frequents ponds, lakes, sluggish streams, spring runs, and roadside ditches in which standing water is present most of the year. Upon the drying up of any of these ditches, ponds, or lakes, the crayfish construct simple burrows which usually penetrate the water table within three feet from the surface.

Disposition of Types.—The male holotype and the female allotype, U. S. N. M. no. 81091, and a second form male paratype are deposited in the United States National Museum. Of the remaining paratypes one male, form I, one male, form II, and one female are deposited in the Museum of Comparative Zoology. One male, form I, one male, form II, and a female in the University of Michigan Museum of Zoology. One male, form I ,one male, form II, and one female, in the Academy of Natural Sciences at Philadelphia. Ten males, form I, six males, form II, 26 females, 76 immature males, and 93 immature females are in my personal collection at the University of Florida.

Relationships.—Procambarus leonensis has its closest affinities with *Procambarus fallax* (Hagen) and *Procambarus pycnogonopodus*, and indeed, may some day prove to be a subspecies of the former. From present information, however, their ranges seem to be entirely separated.

Procambarus pycnogonopodus sp. nov.

Figs. 3, 4, 8, 9, 11, 15, 19, 20, 21, 24, 25, 27, 28, 30, 32.

Diagnosis.—Margins of rostrums with small lateral spines or tubercles, or only slightly interrupted, areola moderately broad with two or three rows of punctations, hooks on ischiopodites of third and fourth pereiopods in the male; first pleopod of first form male bearing only four processes, caudal process obsolete, mesial process subspiculiform, cephalic process in lateral aspect either distinctly recurved (somewhat resembling the head of a bird) or is straight; distal portion of appendage directed ventrad. Distal truncate portion of outer part corneous.

Holotypic Male, Form I.—Body subcylindrical, slightly compressed laterally. Abdomen narrower than thorax (1.5-1.67 cm. in widest parts respectively).

Depth of carapace slightly greater than width in region of caudo-dorsal margin of cervical groove (1.8-1.7 cm.). Greatest width of carapace slightly cephalad of caudo-dorsal margin of cervical groove.

Areola of moderate width (5.7 times longer than wide); with three rows of punctations in the narrowest part; sides parallel for a short distance in middle. Cephalic section of carapace about 2.16 times as long as areola (length of areola 31.7% of entire length of carapace).

Rostrum excavate, reaching base of distal segment of peduncle of antennule; margins converging to tip where they form a sharp spine. Acumen not distinctly set off from rest of rostrum, only faintest indication of interruptions on margins at base of acumen. Upper surface of rostrum polished; ridges on sides not swollen. Tip of acumen not upturned. Subrostral ridges well defined but obscured in dorsal aspect by the upper part of rostrum.

Postorbital ridges prominent, truncate cephalad. Suborbital angles obtuse, extremely weak. Branchiostegal spines well developed. No lateral spines present on side of carapace, only a few small tubercles in region where they normally occur. Surface of carapace punctate dorsad, granulate laterad.

Abdomen longer than thorax (4.1-3.6 cm.).

Anterior section of telson with five spines in left postero-lateral corner and four in right.

Epistome (Fig. 32) broadly semi-ovate with a cephalo-median spine.

Antennule of the usual form; a spine present on ventro-mesial surface of basal segment.

Antenna reaching beyond caudal margin of telson. Antennal scale broad (broadest slightly proximad of middle), extending to middle of distal segment of peduncle of antennule; spine on outer margin strong.

First pereiopod almost identical with that of *leonensis*. A few slight differences are seen in tubercle counts. Length of outer margin of hand and length of carapace subequal.

Hooks present on ischiopodites of third and fourth pereiopods. Basiopodite of fourth pereiopod with a large tubercle directed distad toward hook on ischiopodite.

First pleopod reaching to base of third pereiopods; terminal portion of appendage (outer part) with a heavy tuft of setae which in lateral and cephalic views completely obscures all terminal processes except the mesial. The subspiculiform mesial process extends from the mesial side of the appendage in a distal caudo-lateral direction (not as decidedly so as in *leonensis*). The cephalic process, also subspiculiform, but shorter than the mesial process, arises from the cephalomesial part of the appendage, and directed distad. The central projection is a minute corneous blade extending from the terminal portion of the outer part. The two processes making up the corneous blades hardly discernible; the centrocephalic process, however, is much the larger. Caudal process absent. Truncated end of the outer part largely corneous.

Male Form II.—Differs from male, form I, in the following respects: Rostrum with acumen more definitely set off, but with no spines or tubercles. Postorbital ridges terminate cephalad in small tubercles. A small lateral spine present on each side of carapace. Anterior section of telson with five spines in right postero-lateral corner and four in the left. Epistome isosceles-trapezoidal, with a spine on mid-cephalic border. First pereiopod essentially like that in first form male, differing principally in distribution and number of tubercles. Hooks on ischiopodites of third and fourth pereiopods greatly reduced. First pleopod with same number of terminals, all reduced in size, and noncorneous.

Female Allotype.—Differs from male, form I, in the following respects: Anterior section of telson with four spines in each posterolateral corner. Epistome more irregular but same general shape. Hands much weaker and shorter in proportion.

Annulus ventralis (Plate I, Fig. 9) broadly bell-shaped. Caudal margin shallowly cleft in middle. Sinus originating on cephalic border on mid-ventral line, following rather closely the mid-ventral line to mid-length of annulus, bending gently dextrad, for a short distance caudad, then sinistrad to mid-ventral line, and finally caudad to cut the caudal margin.

Maesurements.—Male (Form I) Holotype: carapace, height 1.8, width 1.7, length 3.6 cm.; areola, width .20, length 1.14 cm.; rostrum, width .59, length .92 cm.; abdomen, length 4.1 cm.; right chela, length of inner margin of palm 1.42, width of palm 1.00, length of outer margin of hand 3.62, length of movable finger (abnormal). Female Allotype: carapace, height 1.70, width 1.66, length 3.26 cm.; areola, width .16, length .96 cm.; rostrum, width .56, length .88 cm.; abdomen, length 3.63 cm.; right chela, length of inner margin of palm .92, width of palm .78, length of outer margin of hand 2.55, length of movable finger 1.49 cm.

Type Locality.—A roadside excavation and adjoining intermittent stream in the flatwoods 5.8 miles west of Wewahitchka on State Highway 52, Gulf County, Florida. At the time my collections were made the stream was practically dry. The specimens were taken in a seine and from shallow, simple burrows about one and one-half feet in depth.

Range and Habits.—Procambarus pycnogonopodus has been collected from seve ncounties west of the Apalachicola River in Florida: Bay, Calhoun, Gulf, Holmes, Jackson, Walton and Washington.

This species, like *Procambarus leonensis,* is somewhat ubiquitous, inhabiting ponds, sluggish and moderately flowing streams, and roadside ditches; on one occasion it was taken from brackish water. It constructs burrows similar to those of *leonensis.*

Disposition of Types.—The male holotype and female allotype, U. S. N. M. no. 81092, and a second form male paratype are deposited in the United States National Museum. Of the remaining paratypes one male, form I, one male, form II, and one female are deposited in the Museum of Comparative Zoology; one male, form I, one male, form II, and one female in the University of Michigan Museum of Zoology. One male, form I, one male, form II, and one female in the Academy of Natural Sciences at Philadelphia. Of the remaining paratypes 5 males, form I, 52 males, form II, 60 females, 26 immature males, and 54 immature females are in my personal collection at the University of Florida.

Relationships.—Procambarus pycnogonopodus has its closest affinities with *Procambarus fallax* and *P. leonensis.* In fact it is difficult on casual examination to distinguish between the females of these three species, and the first pleopods of the males show distinct affinities.

Variation.—Considerable variation is found in this species. In a large number of mature specimens, as well as in nearly all of the immature specimens, the lateral rostral spines are very strongly developed, while in others they are obsolete. Lateral spines on the carapace are also common in this species. The shape of the epistome is quite variable; rounded parts as seen in the holotype (Plate I, fig. 32) are sometimes distinctly angulate. The postorbital ridges often terminate in sharp spines. Even the relative sizes of the chelae are variable. Apparently the least variable character is the first pleopod of the first form male, and even here the cephalic process varies in shape from recurved to straight and spiculiform (Plate II, figs. 24, 25, 27, 28).

NOTE: Due to inadvertent delay in publication of this volume diagnoses of these species appeared earlier in "The Crayfishes of Florida" (Hobbs: Univ. Fla. Pub., Biol. Series 3 (2): 114-115, 117) and thus actually constitute the original descriptions.

LEGEND FOR PLATE I

Pubescence has been removed from all structures illustrated.

Fig. 1 Mesial view of first pleopod (male, form I) *Procambarus leonensis.*
Fig. 2 Mesial view of first pleopod (male, form I) *Procambarus fallax* (Hagen).
Fig. 3 Mesial view of first pleopod (male, form I) *Procambarus pycnogonopodus.*
Fig. 4 Lateral view of first pleopod (male, form I) *Procambarus pycnogonopodus.*
Fig. 5 Lateral view of first pleopod (male, form I) *Procambarus fallax* (Hagen).
Fig. 6 Lateral view of first pleopod (male, form I) *Procambarus leonensis.*
Fig. 7 Mesial view of first pleopod (male, form II) *Procambarus leonensis.*
Fig. 8 Mesial view of first pleopod (male, form II) *Procambarus pycnogonopodus.*
Fig. 9 Annulus ventralis of *Procambarus pycnogonopodus.*
Fig. 10 Annulus ventralis of *Procambarus leonensis.*
Fig. 11 Lateral view of first pleopod (male, form II) *Procambarus pycnogonopodus.*
Fig. 12 Lateral view of first pleopod (male, form II) *Procambarus leonensis.*

LEGEND FOR PLATE II

Pubescence has been removed from all structures illustrated.

Fig. 13 Mesial view of tip of first pleopod (male, form I) *Procambarus leonensis.*
Fig. 14 Dorsal view of carapace of *Procambarus leonensis.*
Fig. 15 Mesial view of tip of first pleopod (male, form I) *Procambarus pycnogonopodus.*
Figs. 16 and 17 Hooks on ischiopodites of third and fourth pereiopods of male, form I, *Procambarus leonensis.*
Fig. 18 Mesial view of tip of first pleopod (male, form I) *Procambarus fallax* (Hagen).
Figs. 19 and 20 Hooks on ischiopodites of third and fourth pereiopods of male, form I, *Procambarus pycnogonopodus.*
Fig. 21 Dorsal view of carapace of *Procambarus pycnogonopodus.*
Fig. 22 Upper surface of right chela, *Procambarus leonensis.*
Fig. 23 Dorsal view of carapace of *Procambarus fallax* (Hagen).
Figs. 24, 25, 27, 28 Variations in the cephalic process of the first pleopod (male, form I) of *Procambarus pycnogonopodus.*
Fig. 26 Lateral view of carapace of *Procambarus leonensis.*
Fig. 29 Epistome of *Procambarus leonensis.*
Fig. 30 Antennal scale of *Procambarus pycnogonopodus.*
Fig. 31 Antennal scale of *Procambarus leonensis.*
Fig. 32 Epistome of *Procambarus pycnogonopodus.*

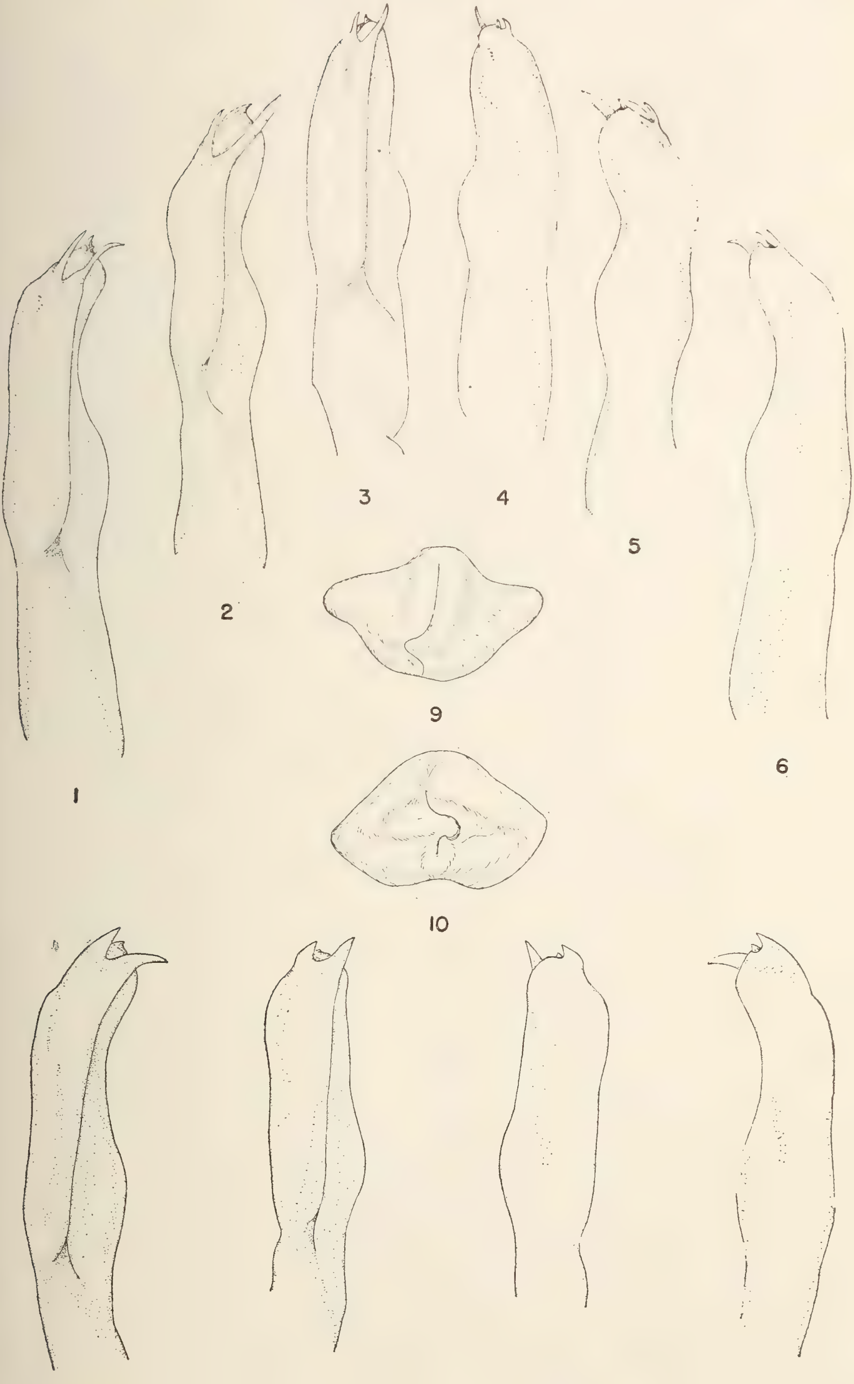

Plate I

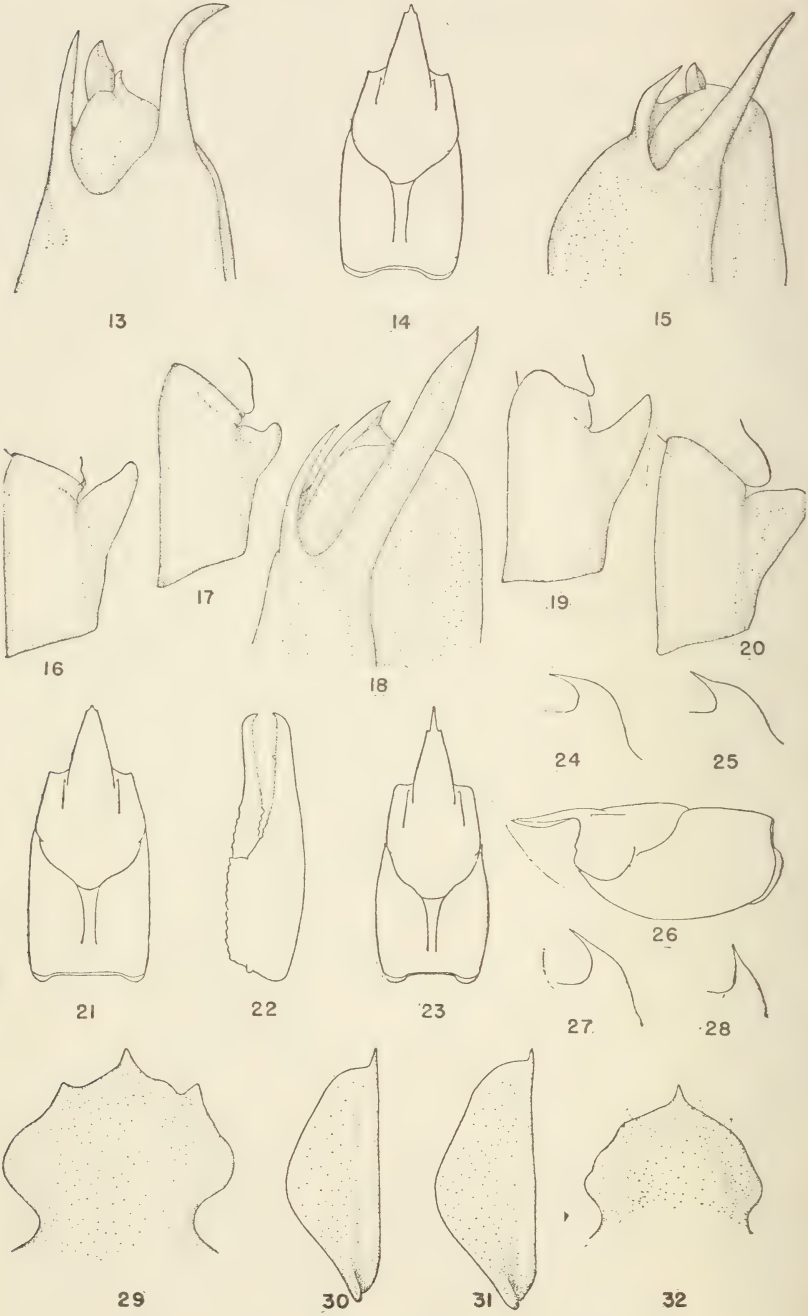

Plate II

PRELIMINARY REPORT ON THE ALGAL FLORA OF SOME FLORIDA SOILS

F. B. Smith and H. R. Ellis
University of Florida

The study of the soil algae dates back to about the middle of the last century and was a natural consequence of the development of the other branches of the science of soil microbiology. Attention was at first centered in nitrogen fixation by this group following the suggestion that this process in soils was biological. However, it was not until recently that the nitrogen fixing ability of certain blue-green algae was definitely established. The study of the occurrence and distribution of the algae in soils has not kept pace with the study of their physiological processes. Consequently, the economic importance of nitrogen fixation in soils by the blue-green algae remains to be determined.

Many of the earlier investigators claimed an increased nitrogen fixation by Azotobacter when algae were present. It is commonly accepted that the algae supply the Azotobacter with a source of available energy. Recent investigations (11) do not support this belief. However, there remains the possibility of other interesting and highly important interrelationships between these organisms.

Esmarch (3) was possibly the first to recognize the importance of soil conditions in limiting the growth and distribution of algae in soils. In a study of some African soils, he found the blue-green algae to be more abundant in cultivated than in virgin soils. In another study (4) differences in soil texture, organic matter content, moisture relationships and soil treatment were observed to affect the occurrence of certain species.

Robbins (9) found algae to occur abundantly in many cultivated soils of Colorado. Of 21 species isolated, 19 were species of the blue-green algae. The soils were described as sandy loam, clay loam, heavy clay, hard, gravelly clay, heavy abode and river bottom silt. This would hardly be recognized as a complete characterization of the soils, but an attempt was made to correlate species with kind of soil.

Bristol (1, 2) investigated the occurrence of algae in soils under different moisture conditions. Moore and Karrer (7) and Moore and Carter (8) studied the distribution of algae in soils at different depths. More recently, Stokes (10) studied the influence of certain environmental factors on the development of algae in the Sassafras loam. It was found that liming had a marked beneficial effect on the growth of algae in this soil. It was also found that additions of active organic matter inhibited the growth of algae, apparently because of a competition with other organisms for the essential elements since normal algal growth occurred after the organic matter decomposed.

The fixation of atmospheric nitrogen, the addition of energy to the soil through the fixation of carbon, and the interrelationships of the algae with the other soil organisms, offer many interesting possibilities for investigation. It has long been known that the algae are a source of food for certain protozoa but the full significance of this to soil fertility is not known. The addition of even small amounts of nitrogen and organic matter to sandy soils low in these constituents may be of large practical value in the management of these soils.

In a majority of the investigations reported the soil has been regarded as incidental only to the occurrence of the organisms; and the characterization of the soil, when attempted at all, was superficial and inadequate. However, in many cases investigators have been aware of the influence of soil type on the occurrence and distribution of certain species. Little, if any, significance can be attached to lists of forms isolated from the soil without regard to soil type differences. The problem is worthy of at least a scientific approach. It was with this in mind that the present investigation was begun. Three soil types are under investigation at the present and although the studies are by no means complete some interesting differences have developed and the results are offered as a progress report. The work will be continued with the same soil types through different seasons and on different types under various conditions of management.

Methods of Procedure

Sufrace samples of virgin Portsmouth fine sand and a resting Norfolk fine sand were taken in September. The different horizons of a virgin Leon fine sand were taken January 1, January 31, March 31, and June 11. Typical profiles of the three soils are described (5) as follows:

1. *Norfolk fine sand.*
   A_1 0-3″ — Gray to yellowish gray fine sand, loose and structureless.
   A_2 3-30″ — Yellow fine sand, incoherent and structureless.
   B ———— — Yellow, friable sandy clay. Depth to clay quite variable, ranging from 30 inches to 6 or 8 feet.

These soils have developed on marine deposits of non-calcareous sand and clay. They occupy the well drained uplands and are gently undulating to rolling in topography. The profile is acid throughout and the reaction of the surface samples of this soil was pH 6.5.

2. *Portsmouth fine sand.*

A_1	0-10″ —	Dark gray to black fine sand.
A_2	10-24″ —	Light gray fine sand.
BC	25″ plus —	Light gray friable sandy clay, slightly mottled with yellow.

Small areas of these soils occur frequently in the flatwoods, usually as marsh or swamp and the permanent water table is usually within 24-30 inches of the surface. The reaction of the Portsmouth fine sand is normally acid throughout the profile. However, the pH of the surface of this soil was 7.2.

3. *Leon fine sand.*

A_1	0-5″ —	Gray fine sand.
A_2	5-12″ —	Bleached layer, white fine sand.
B_1	12-14″ —	Dark gray to black fine sand. Transitional zone.
B_2	14-18″ —	Dark brown fine sand, firmly cemented with organic matter (Hardpan layer).
B_3	18-30″ —	Light brown fine sand. Water table at 30 inches.

The soils occupy extensive areas within the flatwoods and occur on slightly higher positions than the associated Portsmouth soils. The Leon soils have variable drainage conditions, depending upon rainfall and the thickness of the cemented layer. The movement of water through these soils is greatly retarded where the hardpan is well developed and consequently the surface of some of these soils may become flooded during rainy seasons or very dry during drought. The pH of the surface of this soil was 5.13.

Samples from the surface two inches of the Portsmouth and Norfolk soils were collected in sterile pint Mason jars and brought into the laboratory. The moisture content of the soils was adjusted to 30 per cent by the addition of distilled water. The jars were covered and placed in a window where the sun could strike them a part of the day. After about three weeks an abundant growth appeared on the sides of the jars. Some of the growth scraped from the sides of the jars was suspended in tubes of melted and cooled agar. Dilution plates were poured and after growth appeared were transferred to agar slants for identification. The medium used had the following composition:

Ammonium nitrate	0.5 gm
Mono-potassium phosphate	0.2 gm.
Magnesium sulfate	0.2 gm.
Calcium chloride	0.1 gm.
Iron sulfate	trace
Agar	20 gms.
Distilled water	1 liter.

A slightly different procedure from that described above was followed in the case of the Leon fine sand. Amounts of moist soil equivalent to 10 grams of dry soil were weighed into 500 cc. sterilized Erlenmeyer flasks, containing 100 grams of washed sand and 100 cc. of medium. The medium used was the same as that described above, except that the agar was omitted. The flasks were shaken to disperse the algae and then placed in a window where the sun could strike them. After growth appeared, dilution plates were poured and then colonies transferred to agar slants for identification.

RESULTS

Unialgal cultures prepared either directly from the soil or from enrichment cultures were used in most cases for identification. The results obtained are presented in Table 1.

Growth appeared in both the Norfolk and Portsmouth fine sands about three weeks after adjusting the moisture content and incubation in the laboratory. Considerable difficulty was experienced in obtaining unialgal cultures and repeated dilutions were necessary to separate the several species. *Synechocystis aquatilis*, *Aphanocapsa virescens, Oscillatoria limosa, O. violacea*, *Nostoc muscoram* and *N. foliaceum* were found in about equal abundance in both the Norfolk and Portsmouth fine sands.

Growth appeared in the cultures from the A_1 horizon of the Leon fine sand after 22 days and in the cultures from the A_2 horizon after 31 days. At the second sampling, growth appeared in samples from the A_1 horizon after 20 day and in the A_2 horizon after 38 days. At the third sampling, March 14, growth appeared in the A_1 cultures after 12 days and in the A_2 cultures after 15 days. The same algae were found in the A_2 horizon as in the A_1 horizon, but no growth appeared in the cultures inoculated with soil from the lower horizons. The same species were present at the different samplings from January 1 to March 14. However, a sample of the A_1 horizon of the Leon fine sand taken June 11, after a long dry period, contained *Chlorococcum humicola* as the dominant species and an occasional *Rivularia* sp., *Hormidium* sp., *Chlamydomonas* sp., and *Protococcus* sp. Cultures were inoculated June 16 from the sample taken June 11, but growth did not appear until August 16.

DISCUSSION

The soils used in this investigation, although similar in many respects, represent extreme conditions in reaction, organic matter, and moisture relations. The Norfolk fine sand was excessively drained and dry, the Leon fine sand was wet and the Portsmouth fine sand was practically saturated with water. The Portsmouth fine sand is normally acid in reaction, but due to some local abnormality the Portsmouth sampled was slightly basic in reaction. This was probably brought about by seepage of water or drainage from a limed area in the vicinity of the area sampled. The organic matter content of the Portsmouth fine sand is relatively high in comparison with the Norfolk fine sand. The reaction, moisture content and relatively high organic matter content of the Portsmouth soil undoubtedly were factors differentiating the occurrence of species in this type from those occurring in the Norfolk and Leon soils.

The data in Table 1 show the flora of the different soils to be as diverse as their physical characteristics. Only species of Myxophyceae were found in the Portsmouth and Norfolk fine sands, whereas only species of the Chlorophyceae were found in the Leon fine sand at the January and March samplings of this type. However, at the June 11 sampling of the Leon fine sand a species of Rivularia was encountered. This difference in type of flora in the different soils may be due at least in part to soil type diferences. This difference was also undoubtedly partly due to seasonal differences, as was evidenced in the flora of the Leon fine sand at the different samplings. Martin (6) in a study of the occurrence of algae in some virgin Utah soils found a change in kinds that predominated at different times of the year. This investigation will be continued to obtain information on the relative abundance of the different kinds of algae in the various soils at the different seasons of the year.

SUMMARY

Three soil types representing extreme conditions with respect to physical and chemical properties, ranging from permanently wet, swampy conditions, alternate wet and dry flatwoods to the high, dry ridge sands were sampled for biological analysis. Eighteen species of Myxophyceae were found in the poorly drained Portsmouth fine sand. Six of these species were also represented in the Norfolk fine sand, a soil that is excessively drained and relatively dry. The Norfolk fine sand contained nine species of Mysophyceae not found in Portsmouth fine sand. Nine species of Chlorophyceae and one Myxophyceae were found in the Leon fine sand. This soil has a hardpan and is alternately wet and dry. No algae were found in the Leon fine sand below the A_2 horizon, 5 to 12 inch depth. There were indications of a seasonal variation in the algal flora of the Leon fine sand.

TABLE 1.—The Algal Flora of Some Florida Soils

Organisms	Norfolk sand A_1 Horizon	Portsmouth sand A_1 Horizon	Leon fine sand	
			A_1 Horizon	A_2 Horizon
Palmella sp.			X	X
Stichococcus subtilis (Kuetz.) Klecker			X	X
Chrococcus rubrapunctus Wolle	X			
Chrocococcus turicensis Naeg.	X			
Chricococcus turgidus Naeg.	X			
Chroococcus sp.	X			
Synechocystis aquatilis Sauv.	X	X		
Synechocystis sp.	X			
Gloeocapsa sp. A	X			
Gloeocapsa sp. B.	X			
Aphanocapsa virescens (Hass.) Rab.	X			
Microcystis aeruginosa Kuetz.	X			
Microcystis robusta (Clark) Smith	X			
Synechocystis aquatilis Sauv.				
Oscillatoria limosa Ag.	X	X		
Oscillatoria violacea Wallrath	X	X		
Oscillatoria sp. A.		X		
Oscillatoria sp. B.		X		
Nostoc muscorum Ag.	X	X		
Nostoc foliaceum Mougeot	X	X		
Nostoc verrucosum (Linn.) Vauch.		X		
Nostoc sp. A		X		
Nostoc sp. B		X		
Nostoc sp. C.		X		
Microcoleus subtorulosus Kuetz		X		
Cylindrospermam majus Kuetz.		X		
Cylindrospermum sp. A.		X		
Cylindrospermam sp. B.		X		
Gomphosphaeria sp.		X		
Chlamydomonas sp.			X	X
Protococcus viridis Ag.			X	X
Geminella sp.			X	X
Chlorocuccum humicola (Naeg.) Rab.			X	X
Rivularia sp.			X	X
Hormidium sp.			X	X
Lyngbya martensiana Meneghini		X		

TABLE 2.—Percentage Moisture in the Leon Fine Sand at Different Sampling Dates.

Horizon	1/1/41	1/31/31	3/14/41	6/11/41
A_1	7.70	7.25	6.60	0.49
A_2	8.60	7.05	12.00	....
B_1	23.15	22.80	19.95	....
B_2	15.35	18.35	16.20	....
B_3	....	15.60	14.80	....

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(ABSTRACT)

PROGRESS REPORT ON A SURVEY OF THE AMPHIBIA OF FLORIDA

M. Graham Netting and Coleman J. Goin
Carnegie Museum and University of Florida

After several years' investigation on the amphibian fauna of Florida we wish to present to the members of this Academy a summary of progress. We hope that this report will serve to stimulate further collecting, especially in those areas from which additional material is needed.

Although active interest in Florida herpetology may be said to date from 1791 when William Bartram published his "Travels through North & South Carolina, Georgia, East & West Florida, the Cherokee Country," no other paper has stimulated interest in the amphibians and reptiles of this state as has Dr. A. F. Carr's "Contribution to the Herpetology of Florida." Many herpetologists from various institutions have made collections in the state, but since no summary of the fauna was in existence prior to his work much of the collecting was haphazard. As a result many critical areas remained unvisited and many gaps were left in our knowledge of Florida herpetology. This was partcularly true of the amphibians which never have evoked as much interest as have the reptiles. With the accumulation of material from hitherto neglected areas, several new forms have come to light and much information has been obtained on the relationships, geographic variations, and distribution of species that had been little studied before.

Dr. Carr lists twenty-three salamanders and twenty-six frogs and toads in his report. Subsequent work on additional specimens from Florida and other regions has dictated nomenclatorial changes for several of these forms and the revival of some old names that had previously been placed in synonymy. We have described two new races, and our material indicates that several more yet remain to be described. In addition, during the last few years one species of salamander and one species of toad that were not previously known to occur in Florida have been collected in the state. It is probable that several other forms may be added to the state list in the near future. Such forms as *Necturus lödingi* Viosca, *Hemidactylium scutatum* (Schlegel), *Rana sevosa* Goin and Netting, and *Rana vigatipes* Cope are known to occur in adjacent areas, and we believe it is probable that at least some of these may be collected in Florida in the near future.

The amphibians of Florida offer numerous examples of apparently active differentiation. While none of the amphibia show the almost bewildering amount of speciation and racial differentiation exhibited by the Florida crayfish, crane flies, and spiders, they do, nevertheless, break up into races which indicate the existence of five more or less well defined regions of the state. These areas may be listed as: South Florida and the Keys, Peninsular Florida, North Florida, Apalachicola Ravines, and the Western Panhandle.

Comparison of numerous Florida specimens of wide ranging eastern species with large series of extra-limital specimens indicates the existence of certain geographic trends. For example, several species of frogs in the eastern United States show a gradient from the New England specimens with short, obtuse snouts, large feet, and blunt toes to the Florida specimens which have acuminate snouts, small feet, and sharply pointed toes.

Our aim at present is to collect intensively in those areas from which specimens are most urgently needed; to determine the relationships and the geographic variations of all of the species that occur in Florida; to work out the synonymy for these forms; and finally to gather data on the life histories of Florida amphibians.

There still remain numerous unanswered questions relative to our species, and it is incumbent on Florida residents interested in biology to investigate these. The life histories of most of the Florida amphibians are at best incompletely known, and these can be adequately studied only by a person living "on the ground." Furthermore, investigations on habit, habitat preference, seasonal occurrence, and population density for each form are much to be desired. We hope that Florida biologists will interest themselves in these problems, and we can assure them that work along these lines will bring results that will much more than repay the effort expended.

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PROCEEDINGS OF
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CHECK LIST OF FLORIDA MOSSES*

RUTH OLIVE SCHORNHERST
Florida State College for Women

INTRODUCTION

The purpose of this paper is two-fold: (1) the presentation of a history of Bryology in Florida, giving briefly the names of prominent collectors and indicating the regions where they have collected, with the idea of furnishing references to those interested in this phase of botanical study in the state; and (2) furnishing a check list of species of mosses known to occur here.

Miss Lillian Arnold, botanist on the herbarium staff of the Florida Agricultural Experiment Station, has recently published a summary of geological and climatological conditions affecting the distribution of plants in Florida.[1] While the remarks in this paper apply specifically to the distribution of trees, the same conditions are significant in relation to the occurrence of lower plant groups. St. John[2] has discussed the effect of these conditions upon the distribution of ferns in Florida, and a paper by the author[3] is concerned with this problem in relation to mosses.

HISTORY OF BRYOLOGY IN FLORIDA

The first reference to collections of mosses in Florida began to appear in botanical literature about 1900, at the time when the resort areas of the southern part of the state were beginning to attract winter visitors. Many of these early collections represent a pleasant hour or two of browsing about in the hammocks in the vicinity of Miami, rather than any serious survey of the moss flora of that re-

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*Much of the field work necessary for gathering distribution data for this paper was done with the aid of the 1939 Research Grant from the Florida Academy of Sciences. The author wishes to make grateful acknowledgment for this assistance.

[1] Lillian E. Arnold, "Check list of native and naturalized trees in Florida," *Proc. Fla. Acad. Sci.*, Vol. 2 (1937), pp. 53-55.

[2] Edward P. St. John, "Rare ferns in central Florida," *Amer. Fern Journ.*, Vol. 26 (1936), pp. 41-50.

[3] Ruth O. Schornherst, "Phytogeographic studies of the mosses of northern Florida," *Amer. Mid. Nat.*, Vol. 29 (1943), pp. 509-532.

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gion. In 1877 J. Donnell Smith, an early plant explorer, made extensive collections in the southern part of the state, and in 1878, in the company of Coe Finch Austin, explored the Caloosahatchee River. Many of Smith's collections of both years are deposited in various American herbaria. Other visiting botanists who have collected Bryophytes in peninsular Florida, thus adding materially to our knowledge of the flora are A. W. Chapman, Elizabeth Gertrude Britton [4,5,6,7,8] Fred W. Gray,[9] O. E. Jennings, Lewis E. Anderson, and J. K. Small. Until recent years no records of collections in continental Florida have appeared in published reports.

Severin Rapp, who settled in Sanford in 1884, was the best known of the resident bryologists. His death, in his 88th year, in October, 1941, was a distinct loss to the state. His collections from the vicinity of Sanford[10] have furnished much information concerning the bryophyte flora of the Florida East Coast. Lighthipe (or Lightipe), an Episcopal rector, collected around Monticello in Jefferson County about 1890, and more recently Herman Kurz, Olivia Embrey Lay, Erress Arrant, and the author[11,12] in other locations in northern Florida. In the central part of the state, three persons have made outstanding contributions to the information on the moss flora: A. J. Grout,[13,14,15,16] a botanist known everywhere for his contribution to

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[4] Elizabeth Gertrude Britton, "West Indian mosses in Florida," *The Bryologist,* Vol. 6 (1903), pp. 58-61.

[5] ————, "Mosses of Florida collected by Severin Rapp," *The Bryologist,* Vol. 21 (1918), pp. 27-28.

[6] ————, "*Jagerinopsis squarropsis,* n.sp.," *The Bryologist,* Vol. 21 (1918), pp. 48-50.

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[9] Fred W. Gray, "Pygmies, here and there, now and then," *The Bryologist,* Vol. 35 (1932), pp. 18-23.

[10] Severin Rapp, "A list of mosses from Sanford, Florida," *The Bryologist,* Vol. 22 (1919), pp. 50-54.

[11] Ruth O. Schornherst, "A preliminary list of mosses from northern Florida," *The Bryologist,* Vol. 34 (1940), pp. 57-73.

[12] ————, "A second list of mosses from northern Florida," *The Bryologist,* Vol. 44 (1941), pp. 117-119.

[13] A. J. Grout, "Collecting mosses in Florida," *The Bryologist,* Vol. 16 (1913), pp. 27-29.

[14] ————, "Collecting mosses along the Florida west coast," *The Bryologist,* Vol. 30 (1937), pp. 29-30.

[15] ————, "Mosses in Florida lime-sinks," *The Bryologist,* Vol. 43 (1940), p. 112.

[16] ————, "*Moss flora of North America north of Mexico* (Newfane, Vermont, 1928-1940. 3 vols.).

Bryology, and a winter resident of Manatee; J. B. McFarlin[17], until recently botanist at Highlands Hammock State Park; and W. A. Murrill,[18] of Gainesville.

This brief summary indicates a definite spottiness in moss collecting in the state, with many regions yet to be studied and much to be learned concerning the exact distribution of many species. More and more, attention is being given to problems of distribution of plants of all groups, with particular emphasis in this part of the country on tropical species.

CHECK LIST OF MOSSES OF FLORIDA

The nomenclature of the Sphagnaceae follows A. L. Andrews.[19] Classification and nomenclature of the other groups is mainly that found in Grout's *List of Mosses of North America north of Mexico.*[20] Of the two hundred and sixty-five species and varieties of mosses listed as occurring in the state, one hundred and eighty-four have been collected by the author. The others reported have been assembled from a study of material collected by Dr. W. S. Phillips, formerly of the University of Miami, collections by Dr. Herman Kurz of the Florida State College for Women, from material deposited in the herbaria of the New York Botanical Garden, the University of Michigan, and the University of Florida, and from published reports of various authors. Several species appear in the literature as occurring in Florida but show no county records. For completeness they have been included here, although specimens have not been seen by the author, and their authenticity has not been established. These species are indicated by an asterisk (*).

SPHAGNACEAE

Sphagnum cuspidatum Ehrh. var. *serrulatum* Schlieph.
  Alachua, Dade, Franklin, Lake, Lee, Leon, Polk, Orange, Seminole, Wakulla
Sphagnum cyclophyllum Sull. and Lesq.
  Manatee, Polk, Seminole
Sphagnum erythrocalyx Hampe
  Manatee, Polk, Seminole
Sphagnum Fitzgeraldi Ren.
  Jefferson, Orange, Seminole

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[17] J. B. McFarlin, "Mosses of Polk County, Florida, "*The Bryologist,* Vol. 40 (1937), pp. 49-57.

[18] W. A. Murrill, "Bryophytes of Alachua County," Herbarium of the U. of Fla. Agric. Exp. Sta. 1938. (Mimeographed).

[19] A. L. Andrews, "List of North American species of *Sphagnum,*" *The Bryologist,* Vol. 43 (1940), p. 132.

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Sphagnum henryense Warnst.
Leon

Sphagnum imbricatum Chapman
Alachua, Manatee, Santa Rosa

Sphagnum macrophyllum Bernh.
DeSoto, Duval, Lee, Leon, Liberty, Manatee, Orange, Polk, Putnam, St. Johns, Santa Rosa, Seminole, Taylor, Volusia

Sphagnum magellanicum Brid.
Leon, Liberty, Polk, Putnam, Seminole

Sphagnum meridense (Hampe) C. Müll.
Dade

Sphagnum palustre L.
Alachua, Clay, Highlands, Jefferson, Marion, Leon, Liberty, Okeechobee, Polk, St. Johns, Seminole
Sphagnum portoricense Hampe
Clay, Jefferson, Leon, Manatee, Orange, Polk, Volusia
Sphagnum recurvum Beauv.
Alachua, Hillsborough, Leon, Liberty, Pasco, Polk, St. Johns, Seminole, Volusia
Sphagnum strictum Sull.
Alachua, Jefferson, Lee, Leon, Manatee, Okaloosa, Polk, St. Johns, Seminole
Sphagnum subsecundum Nees
Alachua, Duval, Gadsden, Lee, Leon, Levy, Manatee, Seminole, Volusia
Sphagnum tabulare Sull.
Polk, Seminole
Sphagnum tenerum Sull. and Lesq.
Seminole

POLYTRICHACEAE

Atrichum angustatum (Brig.) Bry. Eur.
Alachua, Citrus, Duval, Jefferson, Leon, Liberty, Manatee, Marion, Polk, Seminole, Wakulla
Atrichum crispum (James) Sull.
Jefferson
Atrichum macmillani (Holz.) Frye
Alachua, Duval, Gadsden, Jefferson, Leon, Liberty, Nassau, Wakulla, Walton
Atrichum undulatum (Hedw.) Beauv.
Leon, Liberty
Pogonatum brachyphyllum (Rich.) Beauv.
Duval, Escambia, Franklin, Gadsden, Jefferson, Leon, Liberty, Polk, Seminole
Pogonatum pensilvanicum (Hedw.) Paris
Gadsden, Jackson, Leon
Polytrichum commune Hedw.
Alachua, Duval, Manatee, Marion, Polk, Seminole
Polytrichum commune Hedw. var. *perigonale* (Mx.) Bry. eur.
Jefferson, Leon, Liberty
Polytrichum gracile Smith

FISSIDENTACEAE

Fissidens adiantoides Hedw.
Citrus, Dade, Gadsden, Holmes, Lee, Leon, Levy, Liberty, Manatee, Wakulla

Fissidens adiantoides Hedw. var. *semicristatus* Grout
Dade, Lee, Leon, Palm Beach, Wakulla

Fissidens bryoides Hedw.
Alachua, Dade, Gadsden, Jackson, Liberty, Marion

Fissidens Bushii Card. and Thér.
Alachua, Gadsden, Jackson, Jefferson, Sumter

Fissidens christatus Wils.
Alachua, Citrus, Dade, Gadsden, Lee, Leon, Levy, Liberty, Manatee, Marion, Pasco, Polk, St. Johns, Seminole, Wakulla

Fissidens cristatus Wils. var. *winonensis* (Ren. and Card.) Grout
Wakulla

Fissidens Donnellii Aust.
Dade, Highlands, Jefferson, Lee, Leon, Marion, Seminole, Volusia

Fissidens exiguus Sull.
Seminole

**Fissidens exiguus* Sull. var. *falcatulus* (Ren. and Card.) Grout

Fissidens Garberi Lesq. and James
Alachua, Brevard, Charlotte, Columbia, Dade, Gadsden, Jefferson, Lake, Lee, Leon, Liberty, Martin, Palm Beach, St. Lucie, Santa Rosa, Seminole, Volusia

Fissidens Hallii Aust.
Seminole

Fissidens Kegelianus C. Müll.
Alachua, Citrus, Dade, Marion, Monroe, Polk

Fissidens Littlei (Williams) Grout
Gadsden

Fissidens manateensis Grout
Collier, Jefferson, Lee, Manatee, Seminole, Suwannee

Fissidens minutulus Sull.
Gadsden, Jackson, Leon, Liberty, Monroe

Fissidens obtusifolius Wils.
Jefferson

Fissidens polypodioides Hedw.
Gadsden, Leon, Liberty

Fissidens radicans Mont.
Collier, Dade, Manatee, Marion, Monroe

Fissidens Ravenelii Sull.
Gadsden, Hardee, Jefferson, Leon, Liberty, Pasco, Polk, Seminole

Fissidens subbasilaris Hedw.
Citrus, Collier, Gadsden, Holmes, Lake, Levy, Liberty, Seminole, Volusia, Wakulla

Fissidens subcrenatus Schimp.
Leon

Fissidens taxifolius Hedw.
Alachua, Citrus, Duval, Gadsden, Holmes, Jackson, Jefferson, Leon, Liberty, Manatee, Marion, Wakulla

Fissidens tortilis Hamp and C. Müll.
Citrus, Marion

Fissidens viridulus (Web. and Mohr) Wahlenb.
Alachua, Gadsden, Jackson, Lee, Leon, Liberty, Manatee, Seminole, Volusia

Fissidens viridulus (Web. and Mohr) Wahlenb. var. *texanus* (Lesq.) Grout
Gadsden, Lee, Liberty

ARCHIDIACEAE

Archidium alternifolium (Hedw.) Schimp.
    Dade, Lee, Manatee, Seminole
Archidium Donnellii Aust.
    Leon, Seminole
Archidium floridanum Aust.
    Franklin, Gadsden, Lee
Archidium Hallii Aust.
    Lee, Seminole
Archidium longifolium Lesq. and James
    Dade, Lee, Manatee, Seminole
Archidium ohioense Schimp.
    Franklin, Lee, Levy, Manatee, Seminole

DITRICHACEAE

Bruchia carolinae Aust.
    Lee, Marion, Polk
Bruchia Donnellii Aust.
    Alachua, Duval, Jefferson, Leon, Polk, Seminole
**Bruchia flexuosa* (Sw.) C. Müll.
Bruchia Ravenelii Wils.
    Alachua, Gadsden, Leon, Marion, Polk, Seminole
Bruchia Sullivanti Aust.
    Jefferson, Marion, Polk
Bruchia texana Aust.
    Seminole
Creatodon purpureus (Hedw.) Brid.
    Seminole
Ditrichum pallidum (Hedw.) Hempe
    Alachua, Escambia, Gadsden, Highlands, Jefferson, Leon, Madison, Manatee, Marion, Polk, Seminole, Volusia, Wakulla
Ditrichum pusillum (Hedw.) E. G. B.
    Manatee
Trematodon longicollis Mx.
    Alachua, Clay, Gadsden, Jefferson, Leon, Liberty, Manatee, Polk, Seminole
Pleuridium acuminatum Lindb.
    Leon
**Pleuridium alternifolium* Brid.
**Pleuridium Sullivanti* Aust.

DICRANACEAE

Campylopus angustiretis (Aust.) Lesq. and James
    Duval, Manatee, St. Lucie, Seminole
Campylopus fragilis (Dicks.) Bry. eur.
    Alachua, Putnam
Campylopus gracilicaulis Mitt.
    Collier, Gadsden, Highlands, Lee, Leon, Manatee, Seminole
Campylopus gracilicaulis Mitt. var. *Donnellii* (Aust.) Grout
    Citrus, Duval, Lee, Levy, Liberty, Manatee, Okeechobee, St. Lucie, Santa Rosa, Seminole, Walton

Campylopus introflexus (Hedw.) Brid.
Seminole
**Campylopus tallulensis* Sull and Lesq.
Campylopus tallulensis Sull. and Lesq. var. *subleucogaster* (C. Müll.) Grout
Seminole
Dicranella Herminieri Besch.
Leon, Manatee, Marion, Polk, Santa Rosa, Seminole
Dicranella heteromalla (Hedw.) Schimp.
Alachua, Bay, Leon, Manatee, Seminole, Volusia
Dicranella heteromalla (Hedw.) Schimp. var. *orthocarpa* (Hedw.) Paris
Alachua, Polk, Seminole
Dicranella Hilariana (Mont.) Mitt.
Gadsden, Jackson, Jefferson, Leon, Liberty, Manatee, Polk, Seminole
Dicranella spaerocarpa Card.
Leon
Dicranella varia (Hedw.) Schimp.
Alachua, Gadsden
Dicranodontium asperulum (Mitt.) Broth.
Seminole
Dicranodontium denudatum (Brid.) E. G. B.
Manatee. (Also reported from Florida with no record of place, by L. M. Underwood in 1891. Specimen in herbarium of New York Botanical Garden. Det. E. G. Britton.)
Dicranum condensatum Hedw.
Bay, Brevard, Dade, Franklin, Gulf, Hillsborough, Lake, Leon, Okaloosa, Okeechobee, Orange, Osceola, Palm Beach, Polk, St. Lucie, Seminole, Volusia, Walton.

LEUCOBRYACEAE

Leucobryum albidum (Brid.) Lindb.
Alachua, Citrus, Dade, Duval, Gadsden, Glades, Highlands, Hillsborough, Jefferson, Lake, Lee, Leon, Levy, Liberty, Manatee, Marion, Osceola, Polk, St. Johns, Santa Rosa, Seminole, Volusia, Wakulla
Leucobryum antillarum Schimp.
Alachua, Gadsden, Leon, Levy, Liberty, Polk
Octoblepharum albidum Hedw.
Brevard, Citrus, Collier, Dade, Duval, Highlands, Hillsborough, Lake, Lee, Leon, Levy, Manatee, Monroe, Orange, Palm Beach, Pinellas, Polk, St. Johns, Seminole, Volusia

CALYMPERACEAE

Calymperes Donnellii Aust.
Collier, Dade, Manatee, Polk, Seminole
Calymperes emersum C. Müll.
Dade, Manatee
Calymperes Nashii Williams
Dade
Calymperes Richardi C. Müll.
Dade, Duval, Manatee, Monroe, Sumter
Syrrhopodon filigerus (Aust.) Williams
Dade, Lee, Leon, Manatee, Seminole

Syrrhopodon floridanus Sull.
  Alachua, Collier, Duval, Escambia, Franklin, Highlands, Leon, Levy, Liberty, Madison, Manatee, Polk, St. Lucie, Seminole, Volusia, Wakulla
Syrrhopodon Gaudichaudii Mont.
  Polk
Syrrhopodon incompletus Schwaegr.
  Citrus, Collier, Dade, Jackson, Leon, Levy, Manatee, Polk, Seminole, Sumter
Syrrhopodon ligulatus Mont.
  Citrus, Escambia, Lake, Levy, Liberty, Seminole, Suwannee
Syrrhopodon parasiticus (Sw.) Besch.
  Citrus, Collier, Gadsden, Hardee, Jefferson, Leon, Liberty, Seminole
Syrrhopodon prolifer Schwaegr.
  Liberty
Syrrhopodon texanus Sull.
  Alachua, Citrus, Collier, Duval, Escambia, Gadsden, Holmes, Lee, Leon, Liberty, Manatee, Polk, Santa Rosa, Seminole, Volusia, Wakulla

BUXBAUMIACEAE

**Diphyscium foliosum* (Hedw.) Mohr

POTTIACEAE

Acaulon rufescens Jaeger
  Leon
Barbula agraria Hedw.
  Alachua, Citrus, Columbia, Dade, Franklin, Jackson, Jefferson, Manatee, Marion, Monroe, Leon, Levy, Osceola, Seminole, Wakulla
**Barbula convoluta* Hedw.
Barbula Cruegeri Sond.
  Alachua, Citrus, Columbia, Duval, Franklin, Gadsden, Jefferson, Leon, Levy, Liberty, Madison, Manatee, Seminole, Suwannee, Wakulla
Barbula unguiculata Hedw.
  Seminole
Desmatodon Barbula (Schwaegr.) Grout
  Alachua, Gadsden, Jackson, Madison, Wakulla
Desmatodon plinthobius Sull. and Lesq.
  Columbia, Jackson, Leon
Desmatodon Sprengelii (Schwaegr.) Williams
  Dade, Monroe
Eucladium verticillatum (Brid.) Bry. eur.
  Alachua, Columbia, Gadsden
Gymnostomum calcareum Nees and Hornsch.
  Citrus, Wakulla
Gymnostomiella Orcutti Bartram
  Jackson
Hyophila Tortula (Schwaegr.) Hempe
  Citrus
Tortella flavovirens (Bruch) Broth.
  Dade, Gadsden, St. Johns, Seminole, Volusia
Tortella humilis (Hedw.) Jennings (*Tortella caespitosa* (Schwaegr.) Limpn.)
  Alachua, Citrus, Duval, Gadsden, Hernando, Jackson, Jefferson, Leon, Liberty, Madison, Marion, Seminole

Weisia jamaicensis (Mitt.) Grout
Gadsden
Weisia viridula Hedw.
Alachua, Citrus, Columbia, Duval, Franklin, Gadsden, Jackson, Leon, Liberty, Madison, Manatee, Polk, St. Lucie, Seminole, Suwannee, Volusia, Wakulla
Weisia viridula Hedw. var. *australis* Aust.
Alachua, Bay, Columbia, Duval, Franklin, Gadsden, Hillsborough, Jefferson, Lake, Leon, Liberty, Manatee, Marion, Polk, Seminole, Volusia

GRIMMIACEAE

Ptychomitrium Drummondii Sull.
Gadsden, Jefferson, Suwannee

EPHEMERACEAE

Ephemerum crassinervium (Schwaegr.) C. Müll.
Manatee
Ephemerum crassinervium (Schwaegr.) C. Müll. var. *papillosum* (Aust.) Ren. and Card.
Gadsden, Leon, Seminole
Ephemerum megalosporum (Aust.) Salm.
Leon, Manatee, Polk, Seminole
Ephemerum serratum (Hedw.) Hempe
Gadsden, Leon
Ephemerum spinulosum Schimp.
Duval, Gadsden, Lee, Leon, Seminole
Ephemerum spinulosum Schimp. var. *hystrix* (Lindb.) Grout
Gadsden, Seminole
Nanomitrium Austinii (Sull.) Lindb.
Leon, Polk, Seminole
Nanomitrium Austinii (Sull.) Lindb. var. *floridanum* Grout
Seminole
Nanomitrium synoicum (James) Lindb.
Polk, Seminole

FUNARIACEAE

Aphanorrhegma serratum (Hook. and Wils.) Sull.
Liberty
**Entosthodon Drummondii* Sull.
Funaria calvescens Schwaegr.
Alachua, Columbia, Duval, Gadsden, Jackson, Jefferson, Leon, Liberty, Manatee, Polk, Seminole, Wakulla
Funaria flavicans Mx.
Bay, Franklin, Gadsden, Lee, Leon, Manatee, Pinellas, Polk, St. Johns, Seminole, Volusia, Wakulla
Funaria hygrometrica Hedw.
Alachua, Citrus, Collier, Dade, Duval, Escambia, Gadsden, Jackson, Jefferson, Leon, Manatee, Polk, Sarasota, Seminole
Funaria hygrometrica Hedw. var. *patula* Bry. eur.
Manatee, Polk, Seminole, Volusia

Funaria serrata Brid.
Escambia, Gadsden, Holmes, Jefferson, Leon, Seminole
Physcomitrium turbinatum (Mx.) Brid.
Alachua, Calhoun, Duval, Gadsden, Jackson, Leon, Liberty, Manatee, Polk, Seminole, Wakulla
Physcomitrium turbinatum (Mx.) Brid. var. *Langloisii* (Ren. and Card) E.G.B.
Calhoun, Leon, Polk, Seminole, Wakulla

SPLACHNACEAE

Tetraplodon pennsylvanicus (Brid.) Grout
Clay, Hillsborough, Lee, Leon, Polk, Putnam, Seminole, Wakulla

ERPODIACEAE

Solmsiella Kurzii Steere
Jefferson

ORTHOTRICHACEAE

Macromitrium mucronifolium Hook. and Grev.
Broward, Dade, Manatee, Monroe, St. Johns, Seminole, Volusia
Macromitrium didymodon Schwaegr. (*Macromitrium rhabdocarpum* Mitt.)
Liberty, Seminole, Volusia
Schlotheimia Sullivantii C. Müll.
Citrus, Collier, Dade, Escambia, Gadsden, Hardee, Hernando, Highlands, Jefferson, Lee, Leon, Levy, Liberty, Manatee, Marion, Okaloosa, Polk, Putnam, St. Johns, Santa Rosa, Seminole, Volusia, Wakulla

AULACOMNIACEAE

Aulacomnium heterostichum (Hedw.) Bry. eur.
Gadsden
Aulacomnium palustre (Web. and Mohr) Schwaegr.
Alachua, Franklin, Hernando, Leon, Liberty, Polk, St. Johns, Seminole, Taylor

BARTRAMIACEAE

**Bartramia pomiformis* Hedw.
Philonotis glaucescens (Hornsch.) Paris
Alachua, Duval, Gadsden, Jefferson, Leon, Levy, Liberty, Manatee, Marion, Polk, Seminole, Volusia
Philonotis gracillima Ångstr.
Alachua, Gadsden, Leon, Levy, Liberty, Madison, Marion
Philonotis longiseta (Rich.) E.G.B.
Alachua, Leon, Manatee, Polk, Seminole, Suwannee, Walton
Philonotis sphaericarpa Brid.
Alachua, Gadsden, Jefferson, Lee, Leon, Levy, Liberty, Marion, Seminole, Volusia
Philonotis sphaericarpa Brid. var. *terrestris* Dismier
Jefferson
Philonotis uncinata (Schwaegr.) Brid.
Liberty, Manatee, Polk, Seminole

BRYACEAE

Brachymenium macrocarpum Card.
Gadsden, Leon, Seminole, Volusia
Brachymenium systylium (C. Müll.) Jaeger
Citrus, Liberty, Marion
Bryum argenteum Hedw.
Alachua, Citrus, Gadsden, Leon, Manatee, Polk, Seminole
Bryum argenteum Hedw. var. *lanatum* (Beauv.) Bry. eur.
Polk, Seminole
Bryum bicolor Dicks.
Polk
Bryum bimum Schreb.
Holmes, Wakulla
Bryum capillare Hedw.
Alachua, Citrus, Collier, Dade, Duval, Franklin, Jefferson, Leon, Liberty, Madison, Manatee, Polk, St. Johns, Seminole, Union, Wakulla
Bryum coronatum Hedw.
Collier, Dade, Leon, Manatee, Polk, St. Lucie, Seminole, Volusia
Bryum pseudotriquetrum (Hedw.) Schwaegr.
Wakulla
Leptobryum pyriforme (L.) Schimp.
Seminole
Pohlia Cruegeri (Hampe) Andrews
Duval, Leon, Manatee, Polk, Seminole

MNIACEAE

Mnium affine Bland.
Alachua, Citrus, Duval, Gadsden, Jefferson, Leon, Liberty, Suwannee
Mnium cuspidatum, Hedw.
Alachua, Citrus, Duval, Gadsden, Jackson, Leon, Manatee, Marion, Polk, Seminole
Mnium rostratum Roehl.
Alachua, Duval, Gadsden, Jefferson, Leon
Mnium punctatum Hedw.
Gadsden, Leon

RHIZOGONIACEAE

Rhizogonium spiniforme (Hedw.) Bruch
Alachua, Duval, Gadsden, Highlands, Leon, Liberty, Polk, Seminole, Volusia

RHACOPILACEAE

Rhacopilum tomentosum (Hedw.) Brid.
Citrus, Collier, Dade, Manatee

HYPNACEAE

Amblystegium Jaratzkanum Schimp.
Alachua, Gadsden, Jackson, Leon, Madison, Putnam, Suwannee, Wakulla
Amblystegium serpens (Hedw.) Bry. eur.
Alachua, Duval, Gadsden, Leon, Levy, Liberty, Wakulla

Amblystegium varium (Hedw.) Lindb.
Alachua, Duval, Gadsden, Leon, Liberty, Manatee, Polk, Seminole, Volusia, Wakulla
Amblystegium varium (Hedw.) Lindb. var. *lancifolium* Grout
Alachua, Collier, Dade, Gadsden, Leon, Wakulla
**Brachythecium Fitzgeraldi* (C. Müll.) Ren. and Card.
Brachythecium oxycladon (Brid.) Jaeger and Sauerb.
Citrus
**Brachythecium plumosum* (Sw.) Br. and Sch.
Brachythecium Roteanum DeNot.
Alachua, Jackson, Seminole
Brachythecium salebrosum (Web. and Mohr) Bry. eur.
Alachua, Gadsden, Seminole, Wakulla
Brachythecium splendens Aust.
Citrus, Marion, St. Johns, Seminole
Campylium chrysophyllum (Brid.) Bryhn
Gadsden, Leon, Liberty, Madison, Seminole, Wakulla
Campylium polyganum (Bry. eur.) Bryhn
Seminole
**Campylium polyganum* (Bry. eur.) Bryhn var. *minus* (Schimp.) Grout
Campylium radicale (Beauv.) Grout
Seminole
Chamberlainia acuminata (Hedw.) Grout
Gadsden, Jackson, Jefferson, Leon, Suwannee, Wakulla
**Chamberlainia acuminata* (Hedw.) Grout var. *rupincola* (Sull. and Lesq.) Grout
Cirriphyllum Boscii (Schwaegr.) Grout
Escambia, Gadsden, Jackson, Leon, Madison, Suwannee
Climacium Kindbergii (Ren. and Card.) Grout
Alachua, Citrus, Duval, Jackson, Jefferson, Gadsden, Leon, Polk
Ectropothecium caloosiense (Aust.) E.G.B.
Alachua, Hillsborough, Lee, Seminole
Entodon Drummondii (Bry. eur.) Jaeger and Sauerb.
Alachua, Citrus, Dade, Escambia, Gadsden, Jackson, Jefferson, Leon, Liberty, Marion, Pasco, Polk, Seminole, Sumter, Volusia, Wakulla
Entodon seductrix (Hedw.) C. Müll.
Alachua, Citrus, Collier, Duval, Escambia, Franklin, Gadsden, Holmes, Jefferson, Madison, Manatee, Marion, Leon, Liberty, Polk, Santa Rosa, Seminole, Sumter, Volusia, Wakulla
Eurhynchium hians (Hedw.) Jaeger and Sauerb.
Alachua, Columbia, Dade, Duval, Gadsden, Highland, Jackson, Jefferson, Leon, Liberty, Marion, Polk, Putnam, Seminole
Eurhynchium Rappii (Williams) Grout
Alachua, Duval, Leon, Liberty, Seminole, Wakulla
Eurhynchium serrulatum (Hedw.) Kindb.
Alachua, Citrus, Dade, Duval, Gadsden, Jackson, Jefferson, Leon, Liberty, Polk, St. Johns, Seminole, Volusia, Wakulla
Homalotheciella fabrofolia (Grout) Broth.
Gadsden, Jefferson, Seminole
Homalotheciella subcapillata (Hedw.) Card.
Citrus, Gadsden, Leon, Seminole
Hypnum Patientiae Lindb.
Alachua, Escambia, Gadsden, Jefferson, Leon, Madison, Manatee, Santa Rosa, Wakulla

Hypnum Patientiae Lindb. var. *americanus* Ren. and Card.
Gadsden, Jefferson, Leon, Seminole, Suwannee
Leptodictyum riparium (Hedw.) Warnst.
Alachua, Collier, Dade, Jefferson, Leon, Levy, Manatee, Polk, Seminole
Leptodictyum sipho (Beauv.) Broth.
Collier, Gadsden, Jefferson, Leon, Manatee, Wakulla
Leptodictyum trichopodium (Schultz) Warnst.
Gadsden, Leon, Levy, Marion
Leptodictyum trichopodium (Schultz) Warnst. var. *Kochii* (Bry. eur.) Broth.
Marion
Leptodictyum vacillans (Sull.) Broth.
Seminole
Mittenothamnium diminutivum (Hampe) E.G.B.
Broward, Citrus, Dade, Leon, Manatee, Monroe, St. Lucie, Seminole
Plagiothecium geophilum (Aust.) Grout
Gadsden, Liberty, Marion, Suwannee
Plagiothecium Mariannae Grout
Jackson
Plagiothecium micans (Sw.) Paris
Alachua, Brevard, Calhoun, Citrus, Dade, Duval, Franklin, Gadsden, Glades, Highlands, Hillsborough, Jackson, Jefferson, Lake, Lee, Leon, Liberty, Madison, Manatee, Orange, Pasco, Polk, Putnam, Santa Rosa, Seminole, Volusia, Wakulla
Plagiothecium micans (Sw.) Paris var. *fulvum* (Hook. and Wils.) Paris
Leon, Polk, Seminole
Plagiothecium micans (Sw.) Paris var. *Groutii* (Card. and Thér.) Grout
Manatee, Monroe
Plagiothecium micans (Sw.) Paris var. *latifolium* Grout
Leon, Seminole, Wakulla
Plagiothecium micans (Sw.) Paris var. *minus* Grout
Seminole
Platygyrium repens (Brid.) Bry. eur.
Leon, Liberty
Sciaromium Lescurii (Sull.) Broth.
Leon
Sematophyllum adnatum (Mx.) E.G.B.
Alachua, Citrus, Dade, Duval, Franklin, Gadsden, Gulf, Highlands, Jackson, Lake, Lee, Leon, Levy, Liberty, Manatee, Marion, Polk, St. Johns, Santa Rosa, Seminole, Sumter, Volusia, Wakulla
Sematophyllum caespitosum (Hedw.) Mitt.
Citrus, Collier, Dade, Duval, Glades, Orange, Polk, Seminole
Sematophyllum carolinianum (C. Müll.) E.G.B.
Manatee
Sematophyllum Smallii Williams
Dade
Stereophyllum Donnellii (Aust.) Card.
Charlotte, Lee
Stereophyllum Wrightii (Sull.) Ren. and Card.
Dade, Manatee, Monroe, Polk
Taxiphyllum planissimum (Mitt.) Broth.
Liberty
Taxithelium planum (Brid.) Mitt.
Collier, Dade, Lee, Manatee, Seminole

Vesicularia amphiloba (Spruce) Broth.
  Dade
Vesicularia crassicaulis (Mitt.) Broth.
  Dade
Vesicularia vesicularis (Schwaegr.) Broth.
  Dade, Orange, Seminole

LESKEACEAE

Anomodon attenuatus (Hedw.) Hüben.
  Alachua, Columbia, Gadsden, Jackson, Jefferson, Leon, Liberty, Madison, Seminole, Suwannee, Wakulla
Anomodon minor (Beauv.) Lindb.
  Gadsden, Leon, Liberty, Suwannee, Wakulla
Anomodon rostratus (Hedw.) Schimp.
  Alachua, Columbia, Gadsden, Jackson, Leon, Liberty, Marion, Wakulla
Haplohymenium triste (Cesati) Kindb.
  Gadsden, Liberty
Herpiteneurum toccoae (Sull. and Lesq.) Card.
  (Specimen in herbarium of the New York Botanical Garden marked "*Anomodon Toccoae*. Florida, Featherman 1871. Herb. Coe Finch Austin. Purchased by Columbia College 1885-1887. Det. A. J. Grout." No location given.)
Leskea australis Sharp
  Gadsden, Jackson, Jefferson, Lake, Leon, Madison, Polk, Seminole, Volusia, Wakulla
Thelia asprella Sull.
  Franklin, Hernando, Lake, Leon, Liberty, Manatee, Marion, Polk, St. Johns, Santa Rosa, Seminole
Thelia hirtella (Hedw.) Sull.
  Alachua, Citrus, Duval, Escambia, Franklin, Gadsden, Highlands, Jackson, Jefferson, Leon, Levy, Liberty, Madison, Manatee, Pasco, Polk, Seminole, Volusia
Thelia Lescurii Sull.
  Gadsden, Hernando, Leon, Liberty
Thuidium Alleni Aust.
  Alachua, Manatee, Volusia
Thuidium delicatulum (Hedw.) Mitt.
  Alachua, Citrus, Clay, Duval, Gadsden, Jackson, Jefferson, Leon, Liberty, Marion, Polk, Seminole, Wakulla
Thuidium involvens (Hedw.) Mitt.
  Dade, Duval, Seminole
Thuidium microphyllum (Hedw.) Best
  Alachua, Calhoun, Citrus, Collier, Dade, Franklin, Gadsden, Hernando, Highlands, Jackson, Jefferson, Leon, Liberty, Madison, Manatee, Marion, Polk, Santa Rosa, Seminole, Suwannee, Volusia, Wakulla
Thuidium microphyllum (Hedw.) Best var. *lignicola* (Kindb.) Best
  Alachua, Dade, Duval, Franklin, Gadsden, Jackson, Leon, Levy, Liberty, Madison, Wakulla
Thuidium minutulum (Hedw.) Bry. eur.
  Alachua, Citrus, Collier, Columbia, Dade, Duval, Gadsden, Hernando, Highlands, Jefferson, Leon, Liberty, Madison, Manatee, Marion, Polk, Seminole, Wakulla

Thuidium schistocalyx (C. Müll.) Mitt.
Dade

HYPOPTERYGIACEAE

Hypopterygium Tamarisci (Sw.) Brid.
Alachua

HOOKERIACEAE

Callicostella pallida (Hornsch.) Jaeger and Sauerb.
Alachua, Dade, Lee, Manatee, Pasco, Polk, Putnam, Seminole

Cyclodictyon varians (Sull.) Broth.
Alachua, Duval, Seminole

NECKERACEAE

Neckera disticha Hedw.
Collier, Dade, Hardee, Monroe, Polk, Seminole

Neckera undulata Hedw.
Alachua, Citrus, Collier, Highlands, Orange, Polk, Seminole

METEORIACEAE

Meteoropsis patula (Hedw.) Broth.
Dade

Papillaria nigrescens (Sw.) Jaeger and Sauerb.
Alachua, Citrus, Collier, Columbia, Dade, Gadsden, Highlands, Lake, Lee, Leon, Liberty, Manatee, Martin, Pasco, Polk, Seminole, Sumter, Volusia, Wakulla

Papillaria nigrescens (Sw.) Jaeger and Sauerb. var. *Donnellii* (Aust.) Grout
Collier, Dade, Manatee

PTEROBRYACEAE

Jaegerinopsis squarrosa E.G.B.
Citrus, Gadsden, Leon, Polk, Seminole, Sumter

Pireella cymbifolia (Sull.) Card.
Collier, Dade, Highlands, Lake, Lee, Manatee, Palm Beach, Putnam, Seminole, Volusia

Pireella ludoviciae (C. Müll.) Card.
Alachua, Citrus, Clay, Duval, Marion, Osceola, Seminole, Volusia

LEUCODONTACEAE

Leptodon trichomitrion (Hedw.) Mohr
Alachua, Citrus, Collier, Gadsden, Highlands, Jackson, Leon, Liberty, Polk, Santa Rosa, Seminole, Volusia, Wakulla

Leptodon trichomitrion (Hedw.) Mohr var. *floridanus* (Lindb.) Grout
Alachua, Gadsden, Jefferson, Leon, Seminole, Volusia

Leptodon trichomitrion (Hedw.) Mohr var. *immersus* (Sull. and Lesq.) Lesq. and James
Alachua, Citrus, Duval, Escambia, Gadsden, Holmes, Jackson, Jefferson, Leon, Levy, Liberty, Madison, Polk, Seminole, Volusia, Wakulla
Leucodon brachypus Brid.
Gadsden
Leucodon julacens (Hedw.) Sull.
Alachua, Duval, Gadsden, Jefferson, Leon, Levy, Liberty, Marion, Santa Rosa, Seminole, Suwannee, Wakulla, Walton
Leucodontopsis floridana (Aust.) E.G.B.
Collier, Dade, Lee, Sarasota, Seminole
Pseudocryphaea flagellifera (Brid.) E.G.B.
Collier, Dade, Lake, Seminole

CRYPHAEACEAE

Cryphaea glomerata Schimp.
Alachua, Clay, Collier, Columbia, Gadsden, Highlands, Jackson, Jefferson, Lake, Leon, Levy, Liberty, Madison, Manatee, Marion, Okaloosa, Osceola, Polk, Putnam, St. Johns, Seminole, Volusia, Wakulla
Cryphaea glomerata Schimp. var. *scabra* Grout
Collier, Gadsden
Cryphaea nervosa (Hook. and Wils.) Bry. eur.
Duval

FABRONIACEAE

Clasmatodon parvulus (Hampe) Sull.
Alachua, Citrus, Duval, Escambia, Gadsden, Franklin, Jackson, Jefferson, Leon, Liberty, Madison, Manatee, Polk, Santa Rosa, Seminole, Suwannee, Volusia, Wakulla
Fabronia Donnellii Aust.
St. Johns
Fabronia Ravenelii Sull.
Duval, Suwannee
Schwetschkeopsis denticulata (Sull.) Broth.
Gadsden, Highlands, Jackson, Jefferson, Leon, Liberty, Marion, Polk, Seminole, Wakulla

FONTINALACEAE

Brachelyma robustum (Card.) E.G.B.
Holmes
Fontinalis Sullivanti Lindb.
Alachua

NOTES ON THE DISCOVERY AND BIOLOGY OF TWO BAHAMAN FRESH-WATER TURTLES OF THE GENUS PSEUDEMYS

L. A. Hodsdon, M.D.
Miami
and
Jay F. W. Pearson, Ph.D.
University of Miami

I. DISCOVERY

The existence of a fresh-water or pond turtle on Cat Island, of the Bahamas, had long been asserted by natives of this island, but this form first was brought to scientific attention by Hodsdon when, in 1933, he collected specimens for the University of Miami which were examined by Karl Schmidt, Curator of Zoology of the Field Museum of Natural History, Chicago.

Later, specimens of this species which had been held in captivity on the island were described as a new species, *Pseudemys felis* Barbour. The validity of this species is not yet firmly established.

Three males and three females of this species are still living in Hodsdon's Miami pool, though no young have been reared during these years of captivity.

In the Spring of 1938, Commissioner J. V. Malone, then stationed at Great Inagua of the Bahamas, heard of similar turtles supposed to be on that island. By diligent inquiry and a thorough and arduous search of uncleared jungle in the early Summer of that year he succeeded in locating the ponds in question and captured seven females which, in Pearson's absence from the University, were sent to Hodsdon. Arrangements concerning the scientific identification of these specimens were made between the authors but through a delay over which neither had any control, the turtles did not reach the Field Museum until after a collecting group from Harvard University had visited Inagua, heard of the find, obtained specimens, and had again forwarded them to Boston. Fortunately, Commissioner Malone was recognized in the name assigned, *Pseudemys malonei* Barbour and Carr. It is a privilege to have this opportunity to record in the literature the fact that both of these interesting forms were first brought to scientific attention through the interest of members of the Florida Academy of Sciences.

As soon as his medical practice permitted, Hodsdon took passage for Inagua (a trip of two weeks) in search of the males of *P. malonei.* The following is quoted from his summary of their discovery:

> "I arrived in Great Inagua in the month of July and at once an expedition was organized to sail to Man of War Bay, on the northwest edge of the island, where were located the fresh-water ponds in which we hoped to capture males of the Inagua turtles. Harvard zoological collectors were still in Inagua and hearing of our proposed excursion, requested the privilege of joining us, offering to pay half the expenses. The joint expedition consisted of Commissioner Malone and myself, representing the University of Miami, two Harvard collectors, a boat captain, and two men acting as guides and carriers.
>
> "We found three small, muddy, shallow ponds, the first of which was about one third kilometer in diameter. It was round, almost waist deep, with rushes at one end, and with a few others scattered here and there toward the center. By feeling with our feet we obtained female turtles, hidden under the roots of the rushes. A diligent search for males in this pond proved vain.
>
> "We were badly bitten by water boatmen (Corixidae), an inch or more in length, which fastened onto our legs and bit savagely. These insects seem to be the principal food of these turtles, as revealed by the turtle dejections, which consisted almost entirely of shells and legs of the insects. It seemed strange that such large and hard insects could be caught and swallowed by the turtles and that the massive wing shields (anterior wings) could successfully pass through the intestinal tract.
>
> "Another pond, larger in area but much shallower, having a grove of buttonwood trees in the center, afforded more females. This pond was about a kilometer from the first pond. We used the 'still hunt' method of taking specimens here. We stood patiently on a fallen tree until a turtle head emerged, when a jump and a grab occasionally proved successful. Again we collected no males.
>
> "In the third pond, about three kilometers from the second one, we were successful in capturing four males. They were about one third the size of the females, more cautious, alert and agile, therefore harder to capture. They seldom came up and they snapped viciously when cornered. This pond was still more shallow, evidently in the process of drying up, the mud on the bottom being much harder. With water only knee deep, we could chase a turtle more quickly and take it more adroitly. Yet, as we took only four males in all, I believe there were fewer of this sex in each of the three ponds. Of the four taken, two went to the University of Miami and are still alive in my pool, at my residence northeast of the Miami River. The other two specimens were sent on to the Museum of Comparative Zoology at Harvard."

II. GENERAL BEHAVIOR, NESTING AND EMERGENCE OF YOUNG TURTLES

A cement and stone pool several feet in diameter holding water to a depth of eighteen inches and with a layer of bottom sand and mud had been constructed by Hodsdon to hold three male and three female turtles from Cat Island, *P. felis*. It connected with a larger, circular yard or run, with an enclosing screened fence. Over half of this yard was filled in with clean sand but the remainder was of Miami oolite and river silt, covered with humus, which packs very hard in dry weather. Continuing from Hodson's notes:

> "Males and females of the Cat Island turtle, *P. felis,* and females from Inagua, *P. malonei,* became tame in captivity, very quickly, all crowding each other to take food proffered by hand, though the *P. felis* males are much more nervous than the females. Both the males of *P. malonei* hiss and snap violently when picked up and rarely will rise from the water to take food from the hand. When I go into the turtle yard, all but these males swim up to be fed. They may peer out furtively, but on the slightest motion toward them, they dive out of sight.
>
> "All of the turtles exhibit considerable intelligence. They are fast runners and adroit climbers and live amiably together. They take any kind of animal food and also feed on bananas, custard-apples, and bread.
>
> "In the spring and summer the turtles will eat water hyacinths but will rarely do so in autumn and winter. The warmer weather finds them lively and vigorous, but in cold weather they are torpid and consume less food. During northers they never rise but lie on the bottom where the ground retains warmth beneath them.
>
> "Two years ago four young female *P. malonei,* Inagua turtles, were found in the yard. They grew slowly the first year but in the second year their rate of growth increased. Gambusias (small fish) in the turtle pool were never disturbed until these two-year old turtles were placed in the pool. Since then it has been impossible to keep live fish with the turtles.
>
> "Some weeks before the summer solstice copulation begins. During the long days after the solstice, the females come out and dig holes in the sand for egg laying. The female emerges from the water, looks all around, waits until everything is quiet, selects a suitable spot, and begins to excavate a saucer-shaped, symmetrical hole, two and one-half to three inches deep in the center and several inches in diameter. This she does by pushing the dirt from the center outwards with first one hind foot and then the other, rotating her body slightly at each push until she has completed a circle and her excavation is symmetrical and even. Every stone and pebble is carefully pushed far out. She then lays ten to fourteen eggs, usually ten. If observed or disturbed she goes off into the pool or rests quietly until the disturbance has ceased or the visitor has gone. Then she returns or continues her work, covering her nest so skillfully, when laying is completed, that no one could determine the exact spot of the nest. *P. malonei* turtles appear to lay at intervals of a week, making two or three distinct nests. Some were made in the sand but others in the humus covered ground, when it was soft.

"Early in August of this year I noticed one of the female *P. malonei* turtles acting in a strange manner. She slowly walked along the ground of the yard, with her snout close to the ground, at times almost rooting into the dirt. She stopped and scratched a few teaspoons full of soil away, then advanced an inch or two and repeated the scratching.

"Then she found the right place and dug out a small hole about three inches across and an inch to an inch and a half deep, using her front feet. She then returned to the pool. I was interested and watched the hole.

"In one to two days, young turtles emerged from it!

"I have observed this behavior several times during August and every time, it was followed by the emergence of small turtles from the small hole scratched in the ground by the female. Some six to seven turtles appeared from each hole during the next forty-eight hours after the emergence of the first one.

"The ground in these places had caked in the dry weather of July, following the hard rains of June, and formed a hard mass that small turtles could not have penetrated. Digging in such hard ground the females wore down their nails, and abraded the skin of the fore-feet so badly that they could hardly walk, and for days limped on swollen and infected feet. One turtle had feet swollen to twice normal size and developed abscesses on both front feet, with consequent deep ulcers.

"I believe this to be the first record of this phenomenon, which was observed by several witnesses for added corroboration.

"There is a great mortality during incubation. After some twenty-odd turtles had emerged, I dug up the greater part of the turtle yard with Pearson present and released seventeen living turtles, some not yet emerged from the partly opened shell (as well as some too feeble to survive), and many eggs, perhaps infertile, which at least had not incubated or been hatched. Some of these eggs had been pierced by tree roots. Two fresh nests were also uncovered, less deeply laid and apparently with eggs somewhat different in shape and color, which led us to believe that they may prove to be eggs of the Cat Island turtle, *P. felis*.

"Two small turtles were uncovered in stony ground, with carapace and plastron misshaped, so badly deformed they could not walk. One I found with the neck ulcerated where it had rubbed against a stone during the turtle's struggles to emerge. It has since healed but the deformed turtles died.

"Young turtles are provided with a white 'thorn' on the snout, about a millimeter in length and very sharp and hard. It is doubtless an aid in cutting the leathery shell for it softens and flakes off soon after emergence from the ground and some have already lost it at the time of emergence. It is so firmly attached to the epithelium of the snout that it cannot be picked off without injuring the turtle's head.

"I believe that cold rains may kill some embryos, and I know that some are so firmly imprisoned in hard ground that they cannot escape. This is particularly true of embryos from eggs deposited on the edges of the saucer-shaped nest where the mother has not loosened the soil. Some eggs are eaten by ants, and land crabs undoubtedly dig up an occasional undeveloped embryo.

"After hatching and escaping from the ground there are still other dangers for young turtles. Birds will attach them. My two-year old turtles barely escaped that danger. I had a duck, which, while I was

> getting clean water for the turtle pan, seized one and threw it with considerable force on the stone walk-way. Cats and racoons also attack small turtles.
>
> "As soon as small turtles are hatched they travel toward water. No doubt some fall in land crab holes and are destroyed by the crabs. A young turtle will walk off to a fall, anywhere. Even large turtles of this genus show little instinct or intelligence with reference to the dangers of falling.
>
> "Yet, out of over fifty newly emerged turtles, only two found the water of the pool by their own efforts. The pool is to the northeast of the yard. The majority of them went to the northwest side of the yard and attempted to climb the wire fence. Several climbed to a foot or more. The northwest side marks the Miami River, but the river curves and they could have equally well gone west or south. Four went south, and several went west.
>
> "Once placed in the pool they swim to the bottom for a few minutes, then rise for air and remain floating, unless a shadow passes over them, when they quickly disappear to the bottom again.
>
> "These small turtles will eat meat or fish within a few hours of hatching. Many will snap valiantly a few minutes after emergence, if picked up."

It may be noted that heavy rains occurred in Miami September 20th. Following the rain, twelve more young *P. malonei* turtles emerged from the nests made in sand, with no preliminary digging by the mother. The largest weighed 12.18 gms., the smallest 8.55 gms. On October 1st, two more emerged from sand in the same manner, one more Oct. 4th and ten, Oct. 6th.

On October 2nd, 48 of these young Inagua turtles, *P. malonei*, were released by Hodsdon in the Hialeah branch canal of the Miami River. Their success or failure in this Florida locality will be watched with interest.

III. DIMENSIONS AND FURTHER NOTES ON HATCHING

On September 1, 1941, following a month of sporadic emergence of young Inagua turtles, *P. malonei*, at the suggestion of Pearson, Hodsdon began the careful excavation of the harder ground of the turtle yard, and almost at once uncovered nests of various ages including shell fragments, dead unhatched eggs, immobile young turtles, emerged but imprisoned, and eggs with young turtles already starting to free themselves from their shells.

Old eggs were dark ivory in general coloration, while two fresh nests, one from 4 to 7 inches underground, the other, from 2 to 5 inches below the ground, were paler ivory or cream. All of the eggs are rounded at both ends, almost cylindrical but slightly broader beyond the longitudinal center of the egg. This applies to all eggs uncovered.

One old nest contained 14 eggs, 8 intact but with holes, two of these with palm roots still penetrating them, the others fragmented by turtle emergence.

Another old nest contained 3 immobile young turtles, in aestivation beneath the hard crust of the ground, all in upright position. It also contained two partly emerged turtles, with distorted carapaces and plastrons, mentioned in Hodsdon's notes in the previous section.

Another nest contained 7 free aestivating turtles, one above another, and six eggs with turtles already starting to emerge. This nest was opened at 3:35 p.m. and all the partly hatched turtles had their eyes open. A showed no movement but had its snout free from the end of the egg, B had head free, C had head and front feet free, D, E and F had heads and necks out, as well as front feet. These turtles were free of their shells at the following times, A at 4:20 p.m., B at 4:10, C at 3:46, D at 3:44, E at 3:48 and F at 3:43.

Squirming movements, side thrustings of the fore legs, then forward lunges of the fore legs and doubtless vigorous thrusts of the hind legs, all occurring in sequence and at periodic intervals, eventually freed these turtles from their shells. All showed a broad umbilicus with plates of the plastron soft and spread apart about it. Within a few days the plates had joined and hardened and almost no trace of the connection between turtle and soft parts of the egg remained.

At emergence from the shell all have the carapace arched and the outer rim of plates bent down. Within a few hours the body flattens and the carapace plates level out. Dimensions of a newly emerged turtle average 35 mm. length of carapace at longitudinal axis, 30 mm. across carapace at pelvic girdle's widest region, 16.5 mm. across plastron at second transverse suture, 18 mm. across plastron at third transverse suture. Deviations are slight and do not range over a millimeter or two in any dimension. The average weight is 10.65 grams.

Day-old turtles with flattened carapaces average 38 mm. long by 36 mm. at pelvic girdle (carapace measurements).

Two-day turtles average carapace measurements of 39 mm. long by 35 mm. greatest width.

Month-old turtles average carapace measurements of 51 mm. length by 44.5 mm. greatest width.

Two-year old Inagua turtles, *P. malonei*, average 85 mm. long, center of carapace, 81 mm. wide at pelvic girdle (carapace) and 80 mm. long center line of plastron.

Present weights of a mature male and a mature female of *P. malonei* are as follows, male: 1105.63 gms.; female: 2381.35 gms.

It is worthy of note that in each case, the sores on the feet of females which had been digging holes through which young turtles escaped were larger on the right foot than the left. These sores, from an eighth of an inch to a full inch in diameter, centered behind the first digit, in each case.

In general it would seem that with layings of from 10 to 14 eggs per nest, hatchings and emergence usually average about 50% of the laying.

IV. CONCLUSIONS

1. A new and rare species of turtle, discovered through our interest and its rumored existence, has been successfully maintained and has bred in captivity, a not too common achievement with turtles.
2. It is doubtless, therefore, a valid species.
3. The Inagua turtle apparently lays more than once a year, building at least three nests.
4. The female Inagua turtle is able to determine the time of hatching of the buried eggs, either through instinct, odor or hearing, and takes definite and even painful action to aid the emergence of her young by digging over the nest, thus loosening the ground and permitting the young to emerge.
5. The young turtles can remain alive in the ground for an indeterminate period in a state of aestivation, for we have no positive knowledge that some of the turtles uncovered might not have been from a previous year's laying. They can remain for at least a month, for the period of emergence this year covered exactly a month and each nest showed the remnants of hatched eggs contained at least one or two aestivating turtles that immediately awakened and became active.
6. Inasmuch as we know that these turtles have been used for food in Inagua, it is possible that the turtle might be successfully introduced into this part of the State of Florida, for similar purposes, if protected until it became established.

THE PROVISION OF CONTROLLED SALINITY VARIATIONS IN EXPERIMENTAL MARINE AQUARIA

F. G. Walton Smith
University of Miami

A considerable number of marine organisms exists whose reactions to varying conditions of salinity are of interest to ecologists and physiologists. In the case of horny sponges of the genera Spongia and Hippiospongia their commercial importance lends added interest to investigations of these relations. During the years 1936-40, when the writer was engaged in a survey of the sponge industry of the Bahamas, several localized instances of sponge mortality occurred which appeared to be associated with reduced salinity of the sea-water in enclosed areas following abnormally heavy rains. Similar phenomena occurred at Turneffe, British Honduras, during 1938 and resulted in the loss of a considerable number of sponges.

Experiments were carried out to test the effect upon Spongia and Hippiospongia species of various conditions of reduced salinity, but difficulty was found in keeping them alive in the laboratory. Only by providing vigorous circulation of sea-water through the containing vessel could they be maintained in a healthy state. It therefore became necessary to devise a method of mixing continuously flowing fresh water and sea-water so as to give a steady water supply of constant, pre-determined salinity. The same problem may well arise in the study of other marine organisms requiring continuous water circulation and it is with this general purpose in view that a description is given of an apparatus devised for the particular case of commercial sponges.

The apparatus consists essentially of vessels A and B, supplied with rain water and sea-water respectively, and provided with overflows O in order to maintain constant water levels; tubes F and S to carry the water to tank C, where mixing takes place, and where the mixed water is maintained at a constant level by the overflow tube O; and a tube EM, by means of which the mixed water is taken from vessel C to the experimental tank E_1. Tank E_2 serves as a control and is supplied with sea-water from vessel D, in which the water level is maintained at the same height as in C and by similar means. Vessels C and D are maintained at an equal height above the experimental aquaria E_1, E_2 in order to maintain equal flow through EM

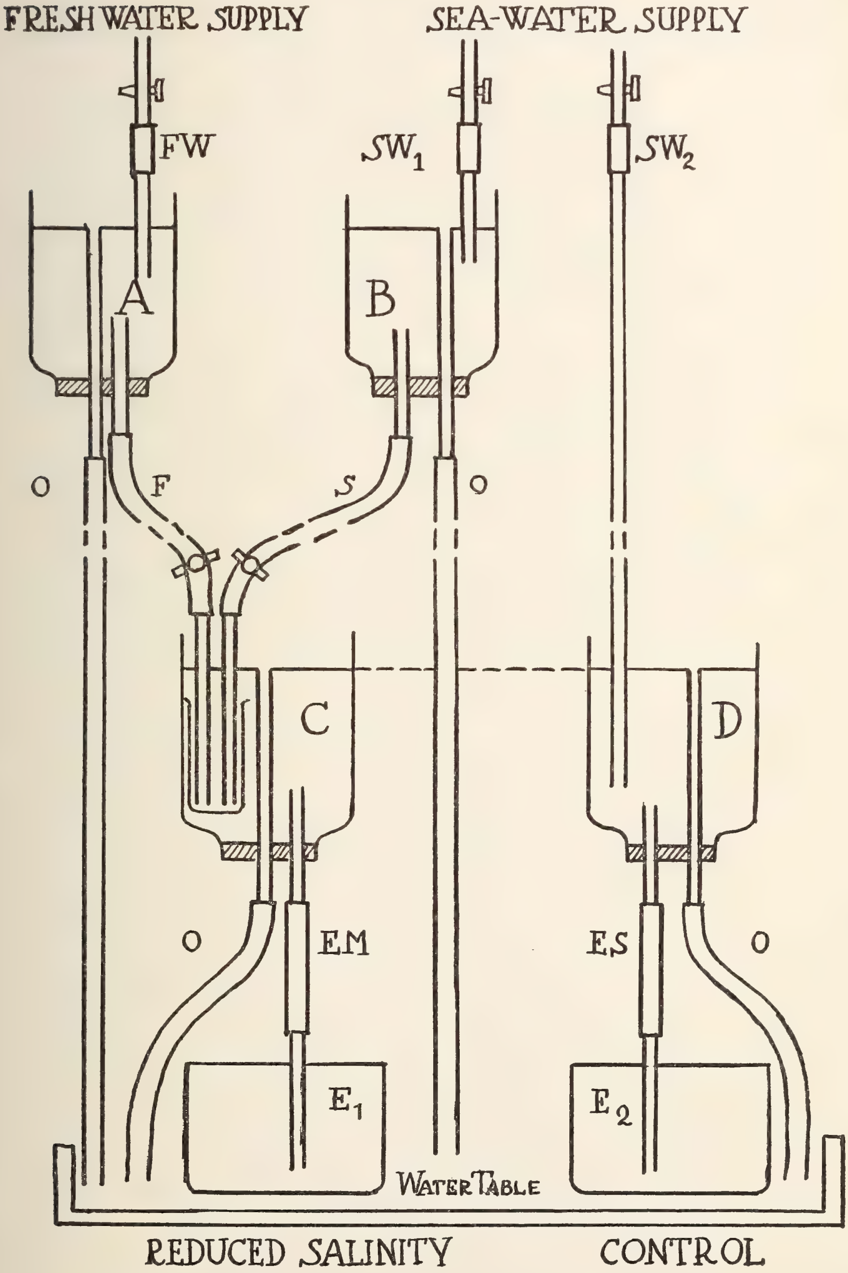

Fig. 1.—Apparatus for control of salinity in sea-water aquaria.

and ES. The height of A and B above C should be similar to that of C above E, in order that no danger of emptying A, B, or C may occur.

Mixing of fresh and salt water takes place in a jar immersed in tank C. The variation in salinity is brought about by the use of screw clips on one of the rubber tubes F and S. For a mixture whose salinity lies between that of rain water and half that of sea-water supply the tube F is kept open and S screwed in until the required salinity is obtained. For salinities lying between half that of sea-water and full sea-water salinity the tube S is left open and F screwed in to the necessary extent. It is necessary to check the salinity after each adjustment. The use of thermometer and hydrometer in conjunction with Knudson's tables gives results sufficiently rapid and accurate for the purpose. During earlier experiments salinity was varied by supporting A and B with cords and pulleys, in order to adjust their relative height above C, but the added constructional details were not justified by increased accuracy of operation. In order that the apparatus may continue to function unattended in spite of fluctuations in the laboratory sea-water supply, it is necessary to observe several precautions. Overflow tubes should be of the largest size possible, whereas the other tubes should be appreciably smaller, but of equal bore to each other. At the start of an experiment, F, S, and ES are pinched off, and the supply through FW, SW_1, SW_2 so adjusted that the water levels in A, B and D do not rise more than one centimeter above the overflow pipes.

A and B are then allowed to discharge into C by releasing F and S. EM is pinched off temporarily, to test the capacity of the overflow. A similar precaution is observed in the case of D by pinching off ES. By allowing only one of the tubes F or S to flow, it may be observed whether the supply is still sufficient under these circumstances to prevent drop of level in C with EM running. Should such a drop occur the flow of EM must be decreased, or the height of A increased.

Suitable vessels for A, B, C and D are not always easily obtained but may be made by cutting off the bottoms of wide mouthed jars. Otherwise, battery jars may be used and the overflow tubes O replaced by constant level syphons, as described by Galtsoff.[4] This may be less convenient for the present purpose than the system described since it is necessary to construct the overflow syphons from wide bore tubing.

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[1] Galtsoff, P. S., Lutz, F. E., Welch, P. S., Needham, J. G., *Culture Methods for Invertebrate Animals* (1937), p. 22.

SPIRAL SCREEN FRACTIONATING COLUMNS FOR THE SEPARATION OF TERPENES

W. DAVID STALLCUP, ROBERT E. FUGUITT and J. ERSKINE HAWKINS
University of Florida

In many cases the most practicable method of separating compounds from the mixtures in which they occur is by fractional distillation. This process makes use of the differences in the boiling points of the components and involves several other factors which are discussed below.

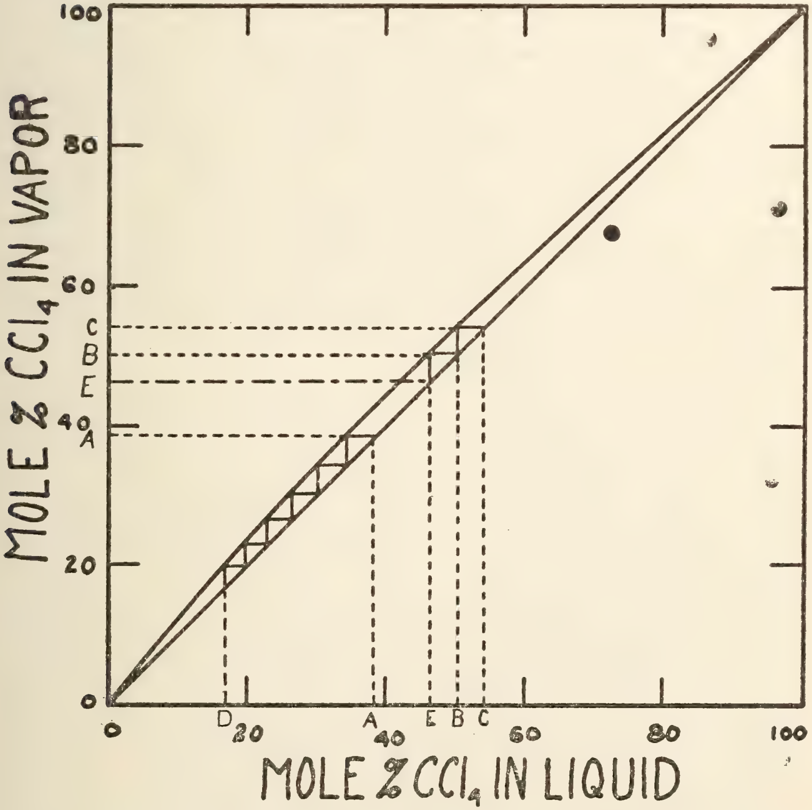

Fig. 1.—Equilibrium diagram for benzene-carbon tetrachloride mixtures.

One of these factors may be explained by considering the equilibrium diagram for benzene-carbon tetrachloride mixtures.[1] See Figure 1. This shows the relation between the composition of the liquid phase and vapor phase for any mixture of the two components which are in equilibrium at the boiling temperature. The upper line is a curve expressing the observed data. The lower line is a diagonal between two opposite corners of the graph and may be used as a reference line. Any point on this line has the same composition along both axes.

According to the graph if a mixture (E) is heated to its boiling point the first vapors resulting would have a composition (B) which are richer in carbon tetrachloride, the more volatile component. Condensation of this vapor gives liquid of the same composition (B). If liquid (B) were distilled and the first vapors condensed, they would have a composition (C). Theoretically, liquid (C) may be obtained from liquid (E) in two separate simple distillations provided equilibrium is maintained between the liquid and vapor phases. This can be approached if small samples are collected. The process is represented by the two steps (EBC) on the graph. Each step is equivalent to a *theoretical plate*.[2]

From an examination of the graph it is obvious that a large number of steps or theoretical plates would be necessary to separate a mixture of benzene and carbon tetrachloride into the two pure components which boil 3.5 degrees apart. To accomplish this by a series of simple distillations would be impracticable. The separation of liquid components has been simplified by the use of vertical heated tubes filled with pieces of material that will furnish surface upon which vapor may condense and re-vaporize. Such tubes, called fractionating columns, are capable of producing separations which require more than one theoretical plate. The number of theoretical plates which a column has depends on the length and diameter of the column, the type of material with which the column is packed, the liquid mixture used and the conditions of operation.

The standard type of laboratory column consists of a glass tube filled with the desired type of packing. A glass heater jacket which is partially covered with two strips of asbestos paper and wound with nichrome resistance wire surrounds the column. This heater jacket is further insulated with an outer glass tube. The liquid to be fractionated is placed in a flask which is connected to the bottom of the column. The vapors which reach the top of the column are condensed by means of a water jacketed condenser in the column head.[3] A thermometer registers the vapor temperature. The condensed vapors may be returned to the column or collected in a receiver. This is regulated by means of an outlet stopcock. When the stopcock is completely closed, all the liquid is returned to the column and the column is operating under *total reflux.*

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[1] Rosanoff, M. A., and Easley, C. W., "On the Partial Vapor Pressures of Binary Systems," *J. Am. Chem. Soc.*, Vol. 31 (1909), pp. 953-960.

[2] For a complete conception of the term "theoretical plate" see Robinson, C. S., and Gilliland, E. R., *Elements of Fractional Distillation*, pp. 81-132. (New York: McGraw-Hill Co., 1939).

The liquid in the distillation flask is heated and vaporizes into the column. If the column heat is maintained close to the boiling temperature of the liquid the vapor will condense and revaporize successively throughout the column. The higher the mixture rises in the column the richer it becomes in the more volatile component. While operating under total reflux, if the column heats are properly controlled for a period of one to several hours a given column will produce results in accord with its maximum number of theoretical plates. Under this condition, the greatest possible number of steps or theoretical plates will exist between the vapor composition in the head and the liquid composition in the distillation flask. To determine this maximum number a test mixture, such as benzene-carbon tetrachloride, is refluxed for the necessary length of time under the stated conditions. Then two small samples are taken, one from the head and the other from the distillation flask. These samples are analyzed for the percent carbon tetrachloride by means of refractive index data for this mixture.[1] By means of the equilibrium diagram, Figure 1, the number of theoretical plates required to separate the mixture to the extent observed may be calculated. For example, if the composition of the liquid in the distillation flask is (D) and the head vapor composition is (A), steps may be drawn as illustrated between the two compositions. The number of steps between the two points (minus one to account for the vapor formed in the kettle) correspond to the number of theoretical plates attained by the column under equiibrium conditions. In this case the number of plates in the column would be five. Column efficiencies are best expressed by *H.E.T.P.*, the height equivalent to a theoretical plate, which is the height of the column divided by the number of theoretical plates.

This maximum performance is obtained while the column is operating under total reflux. If the performance is to approach this maximum during a fractionation of a liquid mixture the condensate must be collected from the head so slowly that the equilibrium between the liquid and vapor in the column is disturbed as slightly as possible. The rate of collection is controlled by means of the outlet stopcock. If this rate is slow most of the liquid will be returned to the column through a calibrated drop-counter. The ratio of the volume of liquid returned to the column to the volume of liquid collected is called the *reflux ratio*. The higher the reflux ratio the more nearly are equilibrium conditions maintained and the greater is the operating efficiency of the column. The effect of varying the reflux ratio upon the separation of two components is illustrated by Rose and Long.[4]

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[3] For details of this type of head see Stallcup, W. D., Fuguitt, R. E., and Hawkins, J. E., "Performance of Some Distillation Columns for the Fractionation of Terpenes," *Ind. Eng. Chem., Anal. Ed.*, Vol. 14 (1942).

The *operating holdup* of the column is the volume of liquid present in the column during the distillation. To measure this a weighed amount of a non-volatile compound such as stearic acid is dissolved in a weighed amount of a volatile compound such as benzene and the mixture is refluxed in the column under operating conditions. A sample of several grams is taken from the distilling flask and weighed. The benzene is removed from the sample on a steam bath and the sample is weighed again. These two weighings are used to calculate the relative amounts of the two compounds in the distillation flask from which the weight of benzene remaining in the flask may be determined. This weight subtracted from the weight of benzene originally present in the flask must be the weight of benzene present in the column while it is in operation. Conversion of this weight to volume gives the operating holdup of the column. This is an important factor, particularly in analytical distillations, since the column holdup should be small with respect to the volume of the mixture which is fractionated.

This laboratory desired efficient fractionating columns for the analysis and the purification of terpene materials. Many efficient columns have been reported, most of which have been designed primarily for petroleum fractionation. Such columns are not necessarily effective in terpene fractionation. To be satisfactory for the latter the columns must perform effectively on viscous and semi-viscous liquids at pressures of 10-20 mm. They must have a low pressure drop and small operating holdup per theoretical plate and must have a high throughput so that distillations can be made in a short time in order to minimize thermal reaction. In addition, for the purposes of this laboratory, the columns must be of economical construction, readily duplicated, and must operate under the heat insulation conditions previously described.

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[4] Rose, A., and Long, H. H., "Calculation of the Effect of Reflux Ratio in Batch Fractionation," *Ind. Eng. Chem.*, Vol. 33 (1941), p. 685.

Several types of column construction were considered. It was finally decided that the spiral screen type of column as developed by Lecky and Ewell[5] should be tried as it gave the most promise of furnishing the desired efficiency and performance.

SPIRAL SCREEN CONSTRUCTION

Laboratory columns for large quantities of material. Four foot lengths of the following columns were made.

Column 1. H.E.T.P. 4.6 inches. Stainless steel gauze (60x60 mesh) was used to make washers of outside diameter (o.d.) 1.50 inches and inside diameter (i.d.) 0.40 inch. One-eighth inch of the outer edge of the washer was cupped at an angle of 45 degrees. A sector of approximately 20 degrees was removed from each washer and the washers were spot-welded together into a spiral group of twenty-four. By joining these groups in a similar manner, any desired length could be obtained. This spiral was then placed on the inner glass tube. A stiff wire spiral spacer, made of ⅛ inch iron wire, with five turns to the inch was screwed into the gauze spiral. Long stiff rods were welded to the ends of the spacer to permit pulling as well as pushing of the screen into the glass tubing. At intervals during the insertion, the exposed gauze spiral was tightened on the inner tube in order to ensure a more uniform fit. When the column was assembled the spacer was removed by turning it in the proper direction.

Column 2. H.E.T.P. 2.8 inches. To make a tighter fit the diameter of the inside tube was increased. Stainless steel gauze washers (60x60 mesh), o.d. 1.50 inches, i.d. 0.71 inch, were used. The column was assembled by the same procedure as described above.

Column 3. H.E.P.T. 1.3 inches. The spiral screen packing of column 2 was removed, ground on the mandrel to the desired outside diameter and inserted in a glass tube of a smaller inside diameter.

Column 4. H.E.T.P. 0.66 inch; operating holdup per plate was 0.90 ml. Stainless steel gauze washers (50x50 mesh) were used of o.d. 1.50 inches, i.d. 0.71 inch. The procedure for assembly of this column followed that for column 1. However, after spot-welding together the washers of this stiffer 50x50 mesh gauze the spiral was ground as described for column 3 and then was placed on the inner rod and inserted in a glass tube of the proper inside diameter.

Laboratory column for small quantities of material.

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[5] Lecky, H. S., and Ewell, R. H., "Spiral Screen Packing for Efficient Laboratory Fractionating Columns," *Ind. Eng. Chem., Anal. Ed.,* Vol. 12 (1940), pp. 544-547.

Column 5. H.E.T.P. 0.72 inch; operating holdup per plate was 0.14 ml. The procedure in making this four foot length of column was the same as that described for column 1 since the grinding used in columns 3 and 4 was not necessary for columns of small diameter. The column was made with stainless steel gauze washers (60x60 mesh), o.d. 0.40 inch, i.d. 0.10 inch. The washers had a 1/16 inch cup around the outer edge. Nickel wire was used as the inner rod and the spacer used had several turns to the inch.

Column Operation

The columns were thoroughly wetted down with the liquid and the column temperature was adjusted to within two degrees of the boiling point of the more volatile component. Column and kettle heats were both controlled electrically. The columns were kept on total reflux until liquid-vapor equilibrium was attained.

580 ml. were collected from a mixture of *d*-pinene and camphene fractionated at 20 mm. pressure through a six-foot length of column of the same construction as column 4. These two compounds boil about 3 degrees apart at this pressure. 320 ml. of *d*-pinene, 110 ml. of a mixture of *d*-pinene and camphene, and 150 ml. of solid camphene were collected. The column was operated under a reflux ratio of about 40 to 1.

32 ml. were collected from a mixture of *d*-pinene and *B*-pinene distilled through column 5 at 20 mm. pressure. These compounds boil at 7.5 degrees apart at 20 mm. A reflux ratio of 25 to 1 was used during the collection of pure materials. A ratio of 40 to 1 was used while passing between pure materials. Under these conditions 16 ml. of *d*-pinene, 11 ml. of *B*-pinene and 5 ml. of mixture boiling between the two pure components were obtained.

Costs

The entire cost of column 4, including all jackets and glass standard taper joints was $37.00; of column 5, $35.00. Labor costs including overhead were calculated at the rate of $1.50 per hour. Two work-hours per foot on column 4 and four work-hours per foot on column 5 were required. These costs do not include the construction of the punches for cutting the spirals which requires about 15 hours each.

Acknowledgments

The authors wish to express their gratitude to Mr. B. J. Otte, Curator of the Chemistry Department, for his many fine suggestions and efforts in obtaining materials and to Mr. Fred Hayes, the machinist, and Mr. P. J. Thompson, the glassblower, for their efforts which contributed to the success of these columns.

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A PRELIMINARY STUDY ON THE DISTRIBUTION AND HABITS OF SOUTH FLORIDA TERMITES

E. Morton Miller and Dorothy B. Miller
University of Miami

This paper should be regarded as a progress report on a single phase of studies being made by the writers on the ecology of termites in Florida. Acknowledgement is given of the aid received from the Council of the Florida Academy of Sciences through their annual Research Grant for 1940; but this paper does not embody the final results of the work made possible by that grant. Further progress reports will be published from time to time, and, when some measure of completeness is reached, such conclusions as may be warranted will be presented in a final summarizing paper.

The only studies made on Florida termites prior to those here discussed were by Banks and Snyder, published in 1920. Collections made in recent years by Dr. A. E. Emerson and ourselves have added new information, noted herein, and have furnished the data necessary for the construction of a practical key for the identification of the Florida species, which follows this report.

All of the thirteen species of termites reported from Florida are represented in the southern half of the state, below a line stretching from Tampa to Melbourne. Two of these however—*Kalotermes approximatus* and *Calcaritermes nearcticus*—are not known to occur south of Bartow, and seem to be more characteristic of the central and northern parts of the state. The distribution of all of these species is still quite imperfectly known, but examination of the records and accompanying field notes leads us to formulate certain tentative generalizations concerning their occurrence.

Kalotermes bequaerti has been found only on the upper east coast keys—Largo and Elliott—and is apparently rare. Little can be said of its habits, except that its galleries closely resemble those of the dry wood termite, *Cryptotermes cavifrons,* and it is evidently confined to hardwood hammocks.

FEB 12 '44

Kalotermes jouteli is largely limited to coastal zones. All of our records fall within ten miles of the shore line. *Jouteli* is very abundant within this area, particularly in dead wood in mangrove swamps. Galleries may be made in very hard wood and the *occupied* galleries are nearly always in fairly substantial material. Well before any portion decays to the point of fragility the termites of this species apparently abandon the zone and work into sounder wood. The species is essentially a dry wood form, although not to the same extent as *K. snyderi.* Soldiers appear to vary in size in correlation with the age and population of the colony.

Kalotermes schwarzi is similar in habits and distribution to *jouteli,* except that *schwarzi* is encountered more frequently in coastal and lower Everglade hammocks than is *jouteli.* The colony workings are difficult to distinguish from those of *jouteli* in the field; the soldiers, however, lack the pigmented eye that is so characteristic of the latter species.

Kalotermes snyderi has sometimes been recorded under the name *marginipennis.* It is the most widely distributed *Kalotermes* in Florida, and seems to be the only one that occurs far inland. It is very characteristic of cypress swamps; in fact, it seems to select cypress wood *in preference* to some other kinds. In South Florida, at any rate, untreated cypress telephone poles are frequently infested by *snyderi,* while nearby wood of other types escapes attack. Man-built structures are also occasionally infested. The moisture requirements appear to be much less than for *jouteli* and *schwarzi;* and although *snyderi* is habitually encountered in cypress swamps, it is not found in damp wood. No explanation can yet be given for these differences in habit. One hesitates to suppose that the distribution is related only to food preferences, because in laboratory colonies all species of *Kalotermes* are able to utilize cellulose from various sources.

The subgenus *Cryptotermes* includes dry wood and "furniture" termites. Two species, *cavifrons* and *brevis,* are encountered in Florida. *Cavifrons* is apparently a native species, while *brevis* is very likely introduced. *Cavifrons* has been found in natural habitats only, and *brevis* exclusively in furniture and buildings. *Brevis* has been collected only in Key West and the Miami area. Both species occur in air-dry wood.

Cryptotermes cavifrons is the most abundant species found in South Florida tropical hammocks. In some localities 75% of the dead, standing limbs and stumps show signs of *cavifrons* attack. Dead stumps or saplings that have begun to decay in the heartwood zones usually have *cavifrons* in the outermost, well-cured and non-decayed zones. Old galleries are frequently filled with excrement in the form of minute, regularly-formed pellets or granules. Such droppings are also accumulated in the galleries of *brevis,* and when shoved out through small exit holes constitute the first clue to workings within furniture or woodwork. *Brevis* is apparently being spread throughout South Florida in infested second-hand furniture. Why *cavifrons* has not yet become of economic importance is a puzzle, but it is our opinion that as man encroaches more and more upon the natural habitat of the species, his buildings may become the subjects of attack by this form.

It is of interest here to note that soldiers in colonies of both *brevis* and *cavifrons* are rare and difficult to locate. The soldiers of both species have truncate heads without enlarged mandibles, and appear to be able to function in colony defense chiefly by using the heads as armored plugs to the invaded galleries.

One other representative of the family Kalotermitidae is found in south Florida. This is *Neotermes castaneus* Burmeister. A second species, *angustoculus,* has been listed by Snyder, but collections by Dr. A. E. Emerson and the senior author at the type locality have provided a graded series of forms whose characters merge into both species categories. *Angustoculus* is, therefore, now considered as synonymous with *castaneus. Neotermes castaneus* is damp-wood inhabiting, and is frequently found in living trees, where it utilizes the sap as a source of moisture. *Castaneus* is known from the east coast keys, the Miami area, and the Pine Crest area in the lower Everglades. There are no other records in Florida except a single, yet unverified, report from Vero Beach region in 1900. In Dade County the species seems to be confined to well-developed hammocks, although a few instances of infestation of avocado trees are at hand. In these cases the original colonizing appears to have occurred via dead, decayed wood at the base of branches. It is doubtful whether entrance is ever made through live, uninjured tree bark.

The genus *Prorhinotermes* is represented in our fauna by one species, *P. simplex.* It is apparently restricted to Dade County, although no ecological reasons for this have yet been deduced. The genus elsewhere, however, is confined to tropical or near-tropical conditions and has never been found more than a few miles inland from marine coasts. *Simplex,* our species, is not known to occur more than five miles inland from the bay shore. The suggestion has been made that salt water is somehow involved in the requirements of these forms, but experiments by University of Miami students have shown no differential survival between experimental colonies supplied with fresh and with sea water moisture. Temperature would seem to be an obvious limiting factor in distribution northward, but *simplex* survives chilling to immobility without observable injury. We are not yet satisfied that the known limits of distribution will remain such with further study.

Prorhinotermes simplex is found in two major habitats. It occurs in damp, but not immersed, wood in mangrove swamps. In such locations use is made of sapwood and, after partial decay, of the heartwood. A large, old colony will frequently have eaten out the inside wood completely and replaced it with a hard, carton-like material composed of excrement and chewed wood. This is the nearest approach in this area to the so-called nest-building habits of West Indian and other tropical species. Pine stumps are also occasionally inhabited by *P. simplex;* the heartwood does not seem to be attacked, as a rule. In either habitat considerable moisture is required. *P. simplex* is definitely a damp-wood, not a subterranean type.

Three species of the subterranean genus *Reticulitermes* are represented in South Florida: *flavipes, hageni,* and *virginicus.* These species, together with *Kalotermes approximatus,* form the temperate element in our termite fauna; all of our other species appear to have been derived from Antillean or Yucatan origins.

All species of *Reticulitermes* require ground contact and moisture for the establishment of a thriving colony; but of the three, *flavipes* has the highest moisture needs. *Hageni* and *virginicus* withstand considerable drying, and, when sealed within galleries, can tolerate "dry wood" conditions. Distribution in the field follows the moisture factor. *Hageni* and *virginicus* are more typical of the dry sand dunes of the West Palm Beach area, the pine flatwoods and dry prairies; while *flavipes* is encountered in moister situations such as hammocks or locally moist spots in the foregoing areas. Species of *Reticulitermes* are less common in the Miami oolitic pineland than in nearby sandy-surfaced zones, and are rare on the upper and lower Keys of the east coast. *Flavipes* is apparently absent from the Keys. This distribution, of course, is obviously related to the nature of the substratum.

These three species develop the most populous colonies of any Florida termites. Furthermore, though classed as subterranean, a strong colony may extend branches ten to twenty feet upward unto wooden structures above ground.

Until 1940, *Calcaritermes nearcticus,* the only representative of its genus in the United States, was known only from three isolated winged specimens described by Snyder in 1933. In the fall of 1940 we were fortunate enough to discover colonies of this species near Winter Park and Bartow. A description of the previously unknown soldier and nymphal forms was published in this journal (Vol. 6, No. 1, pp. 5-8, 1943), and their characters are given in the key which follows this paper.

Although the genus is essentially tropical, this species has not been found in the near-tropical tip of south Florida, and its presence there now seems unlikely in view of the amount of searching that has been done. This presents a zoogeographic problem to which we have no answer as yet.

Judging from the colonies found in north and central Florida, this species has a development somewhat similar to that of *Cryptotermes cavifrons*. *Calcaritermes,* however, occurs in damper wood than *Cryptotermes,* and lines its galleries with a brownish plastering substance.

SEASONS OF ALATE PRODUCTION BY FLORIDA TERMITES
(Based on collections to 1940 by A. E. Emerson, T. E. Snyder, and E. M. Miller)

	Calcaritermes nearcticus	*Cryptotermes brevis*	*Cryptotermes cavifrons*	*Kalotermes approximatus*	*K. bequaerti*	*K. jouteli*	*K. schwarzi*	*K. snyderi*	*P. simplex*	*R. flavipes*	*R. hageni*	*R. virginicus*
January	x		x			x			x		x*	
February			x*							x	x	
March	x*		x*			x	x	x*		x*		x*
April	x*		x			x	x			x		x*
May		x*				x*	x*	x*				x
June		x	x		x*		x*	x				
July												
August							x				x	
September							x	x				
October		x	x		x	x*		x	x		x	
November				x	x		x	x	x*		x	
December			x				x		x*		x	

x—Months in which maturely pigmented alates have been collected, either flying or in colonies.

*—Probable peak or center of swarming period.

One of the most important phases of termite biology concerns the swarming activities of the winged caste, since flying alates are largely responsible for establishing new colonies and dispersing the species. Information about swarming thus far obtained has been summarized in the table given above. It should be emphasized that this is a tabulation of alates, not all of which were actually flying. However, the major swarming period can be estimated and is indicated therein. Generalizations which seem to be justified are these:

1) *Calcaritermes* has a well-defined period of alate production, January through April.
2) *Cryptotermes brevis* swarms with regularity in the summer, May through September. Flights have been observed in evening, and in early morning up to 10 A. M.
3) Species of *Kalotermes* appear to be less closely restricted in alate production to any single season than are the preceding. This is not unexpected in view of the primitive nature of the genus and the equable climate of south Florida.
   These *Kalotermes* species, so far as known, are night or early morning flyers.
4) *Prorhinotermes simplex* swarms regularly from October through January; it habitually flies at dusk between 6 P. M. and 9 P. M.
5) *Reticulotermes hageni* and *R. virginicus*, which are very close taxonomically, appear to be reproductively isolated, i. e., swarm at different periods. *Virginicus* swarms and its alates have been taken only from March through May, while *hageni* alates occur in the fall and winter months. *Virginicus* swarms throughout the daytime until 5 P. M.; *hageni* flies from noon to 5 P. M.

The nature of termite castes is still largely to be investigated. Are the castes genetically or environmentally induced? Is caste determined irrevocably early in the individual termite's life history, or is there plasticity until a later instar? Some evidence showing that in *P. simplex* nymphs are capable until late instar of becoming reproductives, soldiers or workers has been obtained and will be published elsewhere. Individuals with developing wings may, in the absence of soldiers, become soldiers, and in the absence of reproductives become functional reproductives within four weeks' time. Hence the superstition, once common, that destruction of the queen in a colony would result in the death of a colony must be abandoned for this species.

Evidence on the nature of castes may come also from study of intercaste individuals. Several such individuals of *P. simplex* and two of *Calcaritermes nearcticus* have been collected. In both instances these have occurred in laboratory colonies under somewhat artificial conditions.

The most extreme and consistent damage by termites to human property in south Florida is done by *Reticulitermes hageni* and *virginicus*. These subterranean forms have practically always gained access to the structure by faulty construction which permitted ground contact with lumber. In Dade County, *Prorhinotermes simplex* does considerable damage to the structures which have a good moisture content. This species is not subterranean, but attacks moist wood, in contact with the ground or receiving moisture from leaky walls or roofs.

Kalotermes snyderi seems to be the major dry wood termite doing damage to electric line poles in the southern half of the state. In Dade County great numbers of untreated cypress poles have most of the sapwood destroyed. The electric company periodically strips off the damaged wood. This is no doubt useful in arresting rot which follows dry wood termite galleries; but it does not always destroy all the termites.

In Dade County the "furniture" termite, *Cryptotermes brevis*, appears to be spreading—partly through the second-hand furniture trade. Severe damage to valuable furniture may be done by this species, although as a rule the colony grows slowly. Damage to door frames, wood flooring, etc., has also been observed.

Recommendations as to prevention and control have been made from the construction standpoint by E. S. Frash, of the University of Florida Engineering School, and from the biological viewpoint by Snyder (1935), and Kofoid and others (1934). It should be emphasized, however, that knowledge of termite species and habits is a prerequisite for effective control measures, and that each case of infestation must be analyzed individually. Furthermore, the examina-tion and licensing of control agencies by a properly qualified board would be desirable in this state.

A KEY TO THE TERMITES OF FLORIDA

A. E. Emerson and E. M. Miller
University of Chicago and *University of Miami*

IMAGOES

1. Three or more parallel chitinized veins near the costal border of the wing.......... 2
Two parallel chitinized veins near the costal border of the wing.......... 8

2. Median vein much more weakly colored than radius.......... 3
Median vein as strongly colored as the radius, or nearly so.......... 6

3. Median vein ending near the tip of the wing.......... 4
Median vein joining the radius about two-thirds the length of the wing from the suture.......... 7

4. Width of head including eyes 1.38-1.65 mm. Length of forewing from costal end of suture 9.40-12.22 mm. Yellow-brown.......... *Kalotermes* ***schwarzi*** Banks
Width of head including eyes 1.23-1.35 mm. Length of forewing from costal end of suture 8.27-9.40 mm. Yellowish *Kalotermes snyderi* Light
Width of head including eyes 1.23-1.27 mm. Length of forewing from costal end of suture 6.75-6.96 mm. Dark-brown. *Kalotermes approximatus* Snyder
Width of head including eyes .97-1.00 mm. Length of forewing from costal end of suture 7.52-7.71 mm. Yellowish. ***Kalotermes bequaerti*** Snyder

5. Radius with numerous branches and cross veins.......... 6
Radius with few or no branches and cross veins. Wing membrane coarsely punctate.......... *Calcaritermes nearcticus* Snyder

6. Hairs on pronotum short about .06 mm. or less in length. Area between ocellus and eye same color as rest of head *Kalotermes* ***jouteli*** Banks

7. Width of head with eyes .85 -.97 mm.......... *Cryptotermes cavifrons* Banks
Width of head with eyes 1.05-1.15 mm.......... *Cryptotermes brevis* (Walker)

8. Forewing scale barely overlapping the base of the hind wing scale. Profile of top of head convex.......... 9
Forewing scale overlapping at least about half the length of the hindwing scale. Profile of head straight..... *Prorhinotermes simplex* (Hagen)

9 Color of head and body light brown to yellowish brown *Reticulitermes hageni* Banks
Color of head and body dark brown to black.......... 10

10. Ocelli plainly less than their diameter from the eye *Reticulitermes virginicus* Banks
Ocelli either their diameter or more than their diameter from the eye.......... *Reticulitermes flavipes* (Kollar)

---

[2] (*Neotermes angustoculus* Snyder is now believed to be synonymous with *N. castaneus*, since characters formerly used for distinguishing these forms overlap in a graded series of specimens from Paradise Key, the type locality for *angustoculus*.)

SOLDIERS

1. Pronotum approximately as wide or wider than the head............ 2
Pronotum distinctly narrower than the head............................ 9

2. Junction of front and vertex fairly flat; head not sharply truncate 3
Junction of front and vertex nearly a right angle; head sharply truncate 7

3. Third antennal joint distinctly larger and darker than the second or fourth joint.. 4
Third antennal joint not conspicuously different from neighboring joints..*Neotermes castaneus* (Burmeister)

4. Eye pigmented...*Kalotermes jouteli* Banks
Eye unpigmented.. 5

5. Third joint of antennae usually longer than fourth and fifth together. Gula proportionately wide in small forms. Labrum truncate at tip..*Kalotermes schwarzi* Banks
Third joint of antennae about as long as fourth and fifth together. Gula proportionately narrow. Labrum bluntly pointed at the tip.. 6

6. Anterior margin of pronotum deeply to mediumly emarginate. Profile of head with a nearly smooth curve between the front and vertex...*Kalotermes snyderi* Light
Anterior margin of pronotum mediumly emarginate. Profile of head with obtuse angle between front and vertex. Small species. Head width about .97-1.06......................*Kalotermes bequaerti* Snyder
Anterior margin of pronotum slightly emarginate. Profile of head with obtuse angle between the front and vertex *Kalotermes approximatus* Snyder

7. Front slightly oblique, relatively smooth, a deep furrow at the vertex..*Calcaritermes nearcticus* Snyder
Front conspicuously concave, more or less roughened.................. 8

8. Top of head somewhat concave and smooth....*Cryptotermes cavifrons* Banks
Top of head with distinct depression, rough............*Cryptotermes brevis* Walker

9. Sides of head fairly parallel.. 10
Sides of head distinctly converging toward the front *Prorhinotermes simplex* (Hagen)

10. Width of pronotum .81-1.10 mm....................*Reticulitermes flavipes* (Kollar)
Width of pronotum .67-.81 mm.. 11

11. Gula narrower with more abruptly demarcated anterior portion; usually larger and often with more hooked tips on mandibles. *Reticulitermes virginicus* Banks
Gula wider with more gradually demarcated anterior portion; usually smaller and with less hooked tips on mandibles *Reticulitermes hageni* Banks

FISHES OF SILVER SPRINGS, FLORIDA

Carl L. Hubbs and E. Ross Allen
Museum of Zoology, University of Michigan
and
Florida Reptile Institute, Ocala, Florida

Silver Springs, located five miles east-northeast of Ocala, Marion County, comprise one of the largest and most widely known of the crystal-clear outflows from the limestone cap of northern Florida. The chief flow emerges at a constant temperature of about 72° F. from a funnel-shaped depression more than 35 feet deep. The combined discharge is estimated at 22 million gallons per hour. The overflow, Silver Springs Run, meanders 7 miles before entering Oklawaha River, which is a tributary of St. Johns River.

The chemical analysis of the water in parts per million is: silica 32, iron .06, calcium 70, magnesium 11, sodium and potassium 4.4; radicals—bicarbonate 205, sulphate 43, chloride 7.6, nitrate .86; total hardness as calcium carbonate 220.

The springs form a pond with a surface of 2 acres. The current in the pond varies from none to moderate; it is about 4 miles per hour at the spring source. On account of the extreme clarity of the water, rank growths of aquatic vegetation (see figures), with a coarse-leaved *Sagittaria* predominating, beautify not only the shallows but also the sides of the deep spring pits. The bottom is of marl and somewhat cavernous limestone. The shores are low and in part marshy.

In 1929, when in a more or less natural state, the Silver Springs pond was almost wholly surrounded by a marsh, containing much shallow water rich in plant growths. This marsh has since been filled in to a large extent, thus eliminating much of the spawning area for the fish of the spring pond. The edges of the springs have been cleared out and filled in, and a high stone wall has been built around the northeast side of the lake. These changes are probably to a large degree responsible for noticeable decreases in the fish population. Waves from the speed boats continually passing back and forth on the river have probably been a contributing factor, by destroying nests and frightening off the guarding males. Overfishing is not the factor, for no fishing is allowed in the spring or in the outlet. The fish seem to be in good condition, and comparatively free of parasites. Silver Springs fish seldom rub against submerged logs and sticks, as do fish infested with external parasites. Excepting *Signalosa* no species has been observed to die in large numbers. Predators are also few. Fish-eating birds are not very common and only occasionally feed around the springs proper. Racoons though plentiful downstream do not feed in the springs. Softshell turtles occur but are not very common, and they have been seen to feed very little upon fish (in fact these turtles feed every day on the bread that is used to attract the sunfish). Up to seven years ago giant fresh-water shrimp, *Macrobrachium jamaicense* (Herbst), ranging in over-all length to 22 inches, were rather common in Silver Springs, living in the deepest holes and coming out at night to feed on fish, but since then none has been seen. For these reasons we assume that neither predators nor parasites nor overfishing is responsible for the decimation of fish in Silver Springs. The altered environment seems to be the controlling factor.

Species which have become particularly scarce of late are *Mollienisia latipinna, Huro salmoides, Esox niger, Amia calva* and *Elassoma evergladei.* The sunfishes, which are fed daily as a tourist attraction, are thriving.

Through the windows of glass-bottom boats, a diving bell and the "Photo-Sub," many thousands of visitors have enjoyed the entrancing under-water vistas and have observed the aquatic life in a fish's-eye view. The transparency of the water makes it possible to identify the fishes at almost unbelievable distance and to observe their intimate ways of life (see figures). Despite these facts no authoritative account of the fishes of Silver Springs has been published.

One of the authors (E. Ross Allen), as proprietor of the Florida Reptile Institute, has had the opportunity of observing the aquatic life of Silver Springs since 1929. From August 28 to 31, 1935, he assisted Dr. Samuel F. Hildebrand in making an initial inventory of the fishes in these waters. The collection preserved on that occasion has been supplemented from time to time. During the Florida meeting of the American Society of Ichthyologists and Herpetologists, on April 5, 1941, Carl L. Hubbs, with several colleagues and students, observed the fishes in the clear waters and examined the preserved collections in the Florida Reptile Institute. Except for the observations of this date the natural history notes were made by Allen. In 1942 a series of the specimens which had been collected locally was sent for further study to the University of Michigan Museum of Zoology. The latest collection was made on August 4, 1943.

The equipment used in collecting fish in the deep, clear water of Silver Springs was a face mask (goggles) and a spear. The spear or dart was shot from a rubber slingshot. This weapon kills fish at a distance of twenty feet. They can be shot while they are swimming by leading them a few inches. The face mask enables one to see clearly under water.

The systematic remarks are by Hubbs. The paper contributes to our knowledge of (1) the systematics of southeastern fresh-water fishes, (2) the local fish fauna, and (3) the life ways of the fishes of Silver Springs.

Dr. Samuel F. Hildebrand of the Fish and Wildlife Service has generously placed at our disposal his notes on fishes observed in Silver Springs in August, 1935, with remarks on specimens sent to him by Allen in 1936. Dr. Archie F. Carr, Jr., of the University of Florida has also supplied information on the fishes of the Springs.

Collections of Silver Springs fishes are preserved in the United States National Museum, the University of Michigan Museum of Zoology, the University of Florida Department of Biology, and the Florida Reptile Institute.

LEPISOSTEIDAE

Lepisosteus platyrhincus De Kay

FLORIDA GAR

The common gar of Florida has been confused by most authors, for example by Jordan and Evermann (1896: 110-11) with the shortnose gar, *L. platostomus* Rafinesque. Recent studies, however, show that *platostomus* is restricted largely to the silty rivers of the Mississippi Valley. The Florida species are well described and figured as *Lepisosteus platyrhincus* by De Kay (1842: 273, pl. 43, fig. 137), and as *Cylindrosteus castelnaudii* by Duméril (1870: 347, 355-56, pl. 21, figs. 2-2*b*) and by Fowler (1911: 605, 609, pl. 38. figs. 13-14). *C. megalops* Fowler (1911: 605, 609-11, pl. 38, figs. 15-16) was apparently based on a large-eyed example of the same species. Data on proportions in *L. platyrhincus* were given by Hammett and Hammett (1939: 197-209, charts 1-5). These authors suggested that a striped and spotted variety may occur near Englewood, Florida, but large series from the same region, made by the same collector (Stewart Springer), indicate that the differences in coloration are due to age and individual variation.

To judge from the collections examined and from local testimony, this species seems to be the only gar, other than *L. osseus,* in at least the major part of peninsular Florida. On the Atlantic slope it ranges north at least to the Okefenokee Swamp in southeastern Georgia. It is the Florida representative of the spotted gar of the Mississippi Valley, *Lepisosteus productus* Cope, which ranges into western Florida. A specimen from Thomas's Mill Pond, 8 miles south of Marianna, Jackson County, is in the University of Michigan Museum of Zoology. On the basis of this specimen *L. oculatus* was listed for Florida by Carr (1936: 78), before it was learned that *oculatus* is a synonym of *productus.* That species was described as *Cylindrosteus productus* by Cope (1865: 86-87), Duméril (1870: 347, 357), and Fowler (1910: 605, 609, pl. 38, figs. 10-11). Hubbs has recently contrasted *L. productus* with *L. platostomus,* with which it has long been confounded. The full data have not been published, but have been given in summary in papers by Kuhne (1939: 19-21) and by Hubbs and Lagler (1943: 76). In the paper last cited the ratios for the proportionate length of the snout were inadvertently transposed.

L. platyrhincus agrees much better with *L. productus* than with *L. platostomus* in all the characters in which those species disagree, with one exception: the

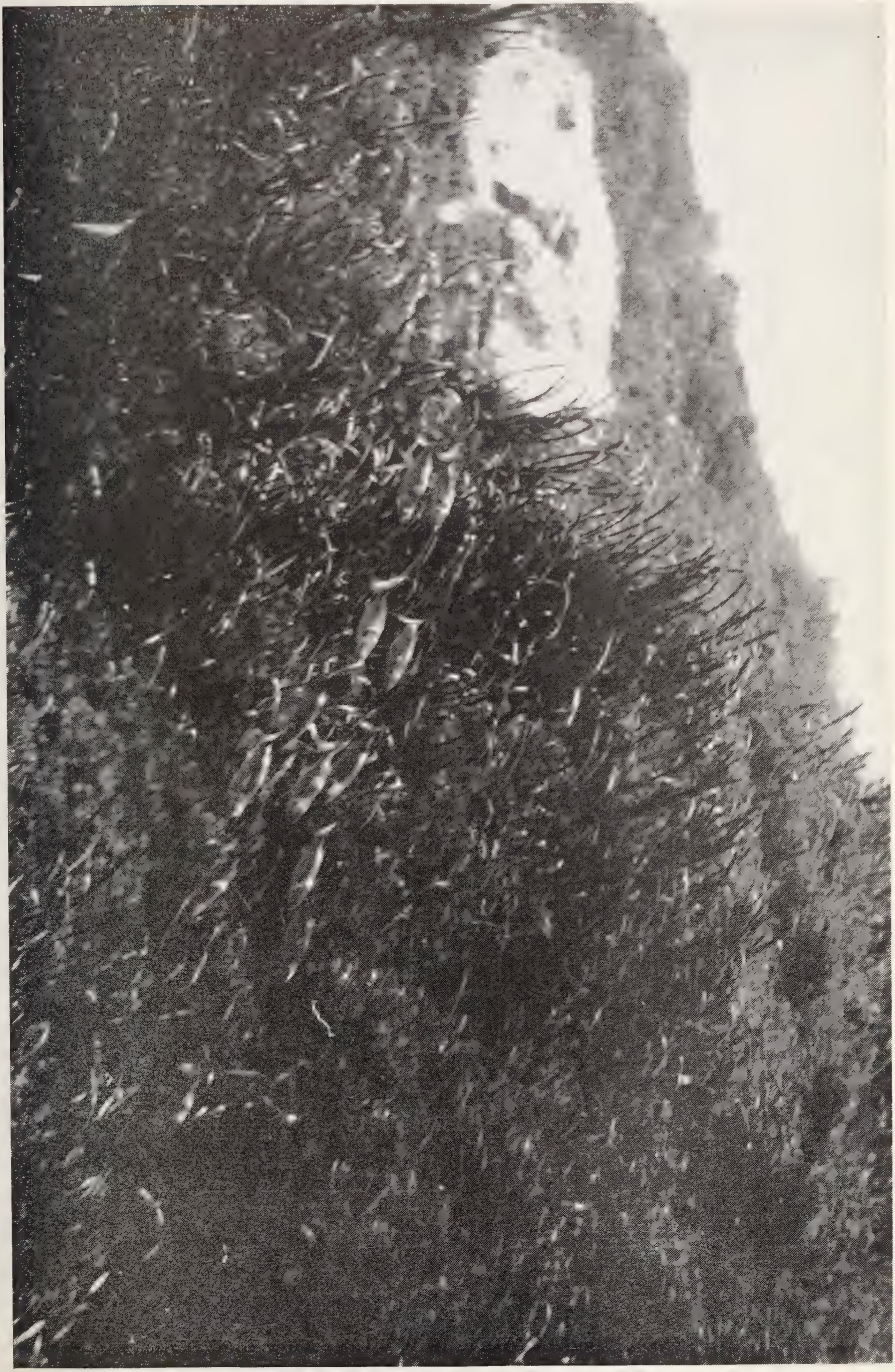

Fig. 1. Main spring at head of Silver Springs, showing a school of stripedmullets (*Mugil cephalus*) passing over a bed of *Sagittaria*. Photograph by E. Ross Allen.

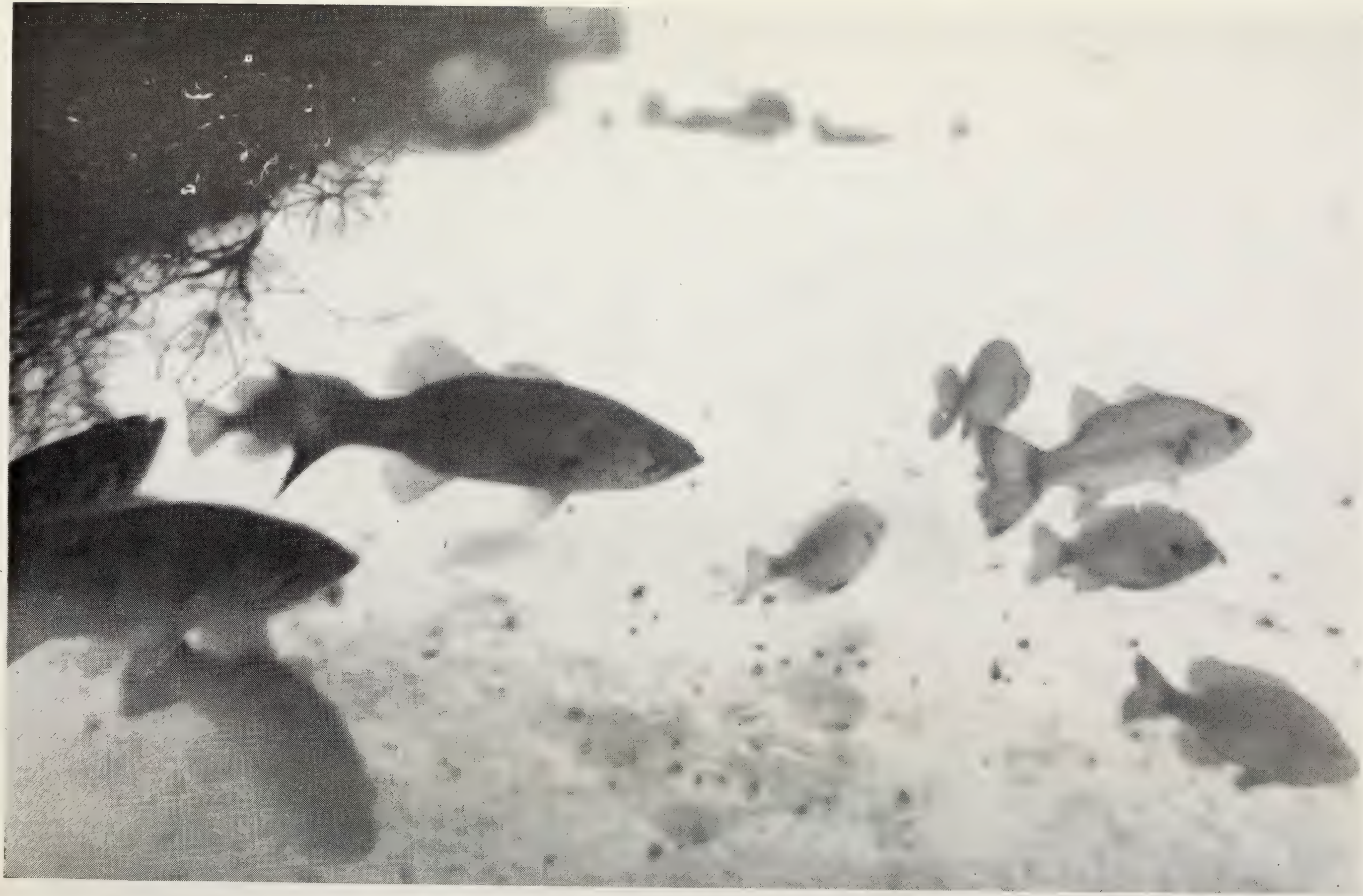

Fig. 2. Largemouth bass (*Huro salmoides*), striped mullets (*Mugil cephalus*) and an eastern bluegill (*Lepomis macrochirus purpurescens*) in "Silver River." A bed of *Sagittaria* covers part of the marl bottom. Photograph by W. Nase, reproduced by permission.

snout is quite as short and broad as in *platostomus*. The ecological conditions generally prevailing through the range of *platyrhincus* are like those selected by *productus*.

This species is fairly common in Silver Springs, and specimens of several sizes are in the collections. On April 5, 1941, a number were seen, some solitary, others in a group at the shallow edge of the deep spring. Here they lined up to await the schools of *Signalosa,* on which they were feeding. Some broke the surface, obviously to breathe. The largest were about two feet long.

Lepisosteus osseus osseus (Linnaeus)

EASTERN LONGNOSE GAR

The single Silver Springs specimen at hand, although only 195 mm. long to the end of the lateral line scales, already shows the roughening of the anterior trunk scales (apart from the denticles) that is characteristic of the Atlantic Coastal form of *L. osseus*. This character was pointed out by Cope (1865: 86-87), Duméril (1870: 326) and Fowler (1911: 606, pl. 38, figs. 3-4), but otherwise has generally been overlooked. Whether it distinguishes a full species, as thought by the authors quoted, or only a geographical subspecies, remains to be determined. An adult was collected in Silver Springs on August 31, 1935, but it has not been studied by us.

The local form of the longnose gar attains a larger size than does the Florida gar: the largest ones are about four feet long and robust in build.

Longnose gars are much less plentiful in the Silver Springs region than they are in many streams of central Florida. Some, gowever, may be seen at any time of the year except on cold days, when they probably go into hiding. They seem to become more abundant in warm weather and probably migrate upstream in the spring. They seldom frequent the main spring "boil" at the stream head (none were seen there on April 5, 1941): they usually stay downstream in deep holes and eddies. In the deep water they may be seen during the day swimming slowly back and forth, occasionally rising to break the surface in a smooth roll. Others may be observed in shallow water in dark, shady places, under bushes and logs, resting on the bottom as though asleep. Once in a while one may be seen with a four or five inch "brim" (*Lepomis,* sp.) in its mouth. They seem to do much of their feeding nocturnally. They have a habit of lying near the surface at night, and persons paddling along in a canoe in the dark are often startled by a sudden splash as the gars ruh off. On such occasions small gars sometimes jump into the boat.

The courting habits of the longnose gar have been observed locally. During the day two males have often been seen following one female. The fish then swim very close together, with the males just above or just below the female.

AMIIDAE

Amia calva Linnaeus

BOWFIN

Locally known as "mudfish," this species is not very common in the springs. One specimen was collected on August 28, 1935, and two others on August 4, 1943. A few were seen in the head pond, in the daylight on April 5, 1941. They show no marked seasonal changes in abundance. Usually about a dozen can be seen by looking for them at night with a light. Shallow pools just off the main stream seem to be a preferred habitat. While swimming with a face mask in the spring holes I (Allen) have seen them hiding on the bottom in the deep-water "grasses."

Occasionally they swim in a vertical position to the surface, tadpole-fashion, to gulp air and return to the bottom.

At times the bowfin are seen nosing along the bottom, presumably in search of crayfish. It is commonly thought that this fish is a destructive predator. The Negroes consider the flesh good eating, but the meat is unattractive to the white people because it is so soft. The largest local specimen on which there is a definite record weighed 10.5 pounds.

A compact swarm of young "mudfish," resembling a school of young catfish, was once found next to the bank. The vividly-marked fish were about two inches long. They were packed so closely that they could be scooped up by the handful. Obviously the bowfin in Florida has habits similar to those observed in the North (Reighard, 1903).

CLUPEIDAE

Signalosa petenensis vanhyningi Weed

FLORIDA THREADFIN SHAD

The genus *Signalosa* was unknown as far east as Florida until 1925, when Weed (pp. 142, 145-146) described the Florida form as *S. atchafalayae vanhyningi.* A study of an abundance of material, coming from the coastal lowlands from Florida to El Petén, Guatemala, seems to indicate that neither *S. mexicana* nor *S. atchafalayae* should be specifically separated from *S. petenensis* (Günther).

This small relative of the gizzard shad is not regularly present in the pool of Silver Springs but occasionally invades these waters in immense droves. The invaders probably come from St. Johns River, whence Fowler (1941: 229, figs. 1-2) reported the species (as *S. vanhyningi*) to be common. So far as known, schools first arrived in 1933 but these soon disappeared. The next occurrence was in 1941, when countless numbers suddenly appeared, and many died, to produce a smelly nuisance. They deserted the springs on March 15 but returned about a week later. During the latter half of March the schools were too dense to be seen through. The fish even got into one's bathing suit. On April 5, these shad were somewhat scarcer but still excessively abundant. Later they disappeared. Their return will be eagerly watched for. The possibility of cyclic behavior will be kept in mind.

These fish swam in dense, compact schools, acting in surprising unison (as indicated by widely shown motion pictures as well as direct observation). Whole areas flashed aside on attack by a predator, but the gap thus made was soon filled in. Others jumped to escape the enemy.

The individuals of a school maintained remarkably parallel courses, as they rushed about ceaselessly, day and night. Most of the schooling was near the surface, or in large sheets extending from near the surface to the mid-depths of the deepest spring hole. Some schools penetrated into the deeper waters. Much of this behavior agreed with the descriptions and theories of schooling published by Parr (1927).

It is something of a mystery how so many thousands of plankton-feeding fish found subsistence in the crystal water of Silver Springs. They did not appear to be feeding.

The threadfin shad observed on April 5 varied much in size but all were small fish. They were very silvery, but one could see the dark streaks of which two stood out sharply in lateral view. The shoulder spot was not very conspicuous.

Locally, these fish were identified as "menhaden," and were fancifully supposed by some to have entered the springs from the sea by the way of underground waters!

Dorosoma cepedianum (LeSueur)

GIZZARD SHAD

Some specimens of gizzard shad from Silver Springs are in the preserved collection. A few were seen on April 5, 1941, schooling with *Signalosa*. They were recognizable in the water by reason of their much deeper body, larger size, and more prominent shoulder spot. The gizzard shad travel in small schools, usually in the deeper spring holes, and have been seen feeding like mullets off the vegetation.

CATOSTOMIDAE

The paucity of suckers in peninsular Florida is exemplified by the finding of only one species in Silver Springs.

Erimyzon sucetta sucetta (Lacépède)

EASTERN LAKE CHUBSUCKER

On April 5, 1941, a few large adults of this sucker, carp-like in size and build, were seen in the springs, at depths of 10 to 25 feet. They were cruising over the *Sagittaria* beds. The species is very common locally and is frequently seen travelling during the day in small schools or in pairs. A specimen 274 mm. in total length was collected on August 28, 1935.

CYPRINIDAE

Only two species of the minnow family were observed in Silver Springs, and neither of these was abundant. In few parts of the Holarctic Realm, apart from the peninsula of Florida, could one find such a rich fresh-water fish fauna with so poor a contingent of Cyprinidae.

Notemigonus crysoleucas boscii (Valenciennes)

SOUTHEASTERN GOLDEN SHINER

Silver Springs is inhabited by a type of golden shiner so unlike the ordinary representatives of the species as to be scarcely recognizable on first sight. After making allowances for magnification in the clear water it seems that the golden shiners here grow to a length of almost or quite one foot. Even more surprising is the robustness of the body. A specimen 222 mm. in standard length is 85 mm. in greatest body depth, and is therefore nearly two-fifths as deep as long; the greatest width is 40 mm. The very deep scales are set off with unexpected conspicuousness by dark basal bars. In this example there are 16 principal anal rays: a typical number for subspecies *boscii*. The caudal fin was seen to be red in life.

Most of the golden shiners seen in Silver Springs are large adults. Smaller, less bulky individuals are probably quickly consumed by the hordes of predacious fishes. Small ones were collected in 1935 and 1936.

Notropis, species

FLORIDA SHINER

A small, dark-striped minnow was observed on April 5, 1941, and on other occasions, near the weeds in the shallow waters of the springs. It is probably the Florida shiner, a species which has been confounded with *N. xaenocephalus* and *N. roseus*.

AMEIURIDAE

Ictalurus lacustris punctatus (Rafinesque)

SOUTHERN CHANNEL CATFISH

Among the myriads of catfish in Silver Springs one observes (as we did on April 5, 1941) a number of very large fish with caudal fins more deeply emarginate than in the common *I. catus*. Since in ameiurids this fin becomes more rounded and less forked with age, these large fish surely represent a second species. They are unlike the usual run of channel catfish in being blackish, without evident dark spots, but mature adults of *I. lacustris* exhibit this color phase, and all fish in Silver Springs tend to be dark. A few moderately light-colored half-grown individuals were seen.

In the depths of the spring holes, in limestone recesses from which the water boiled out, the largest catfish were seen on April 5 to be in territory-holding pairs. One fish in each couple, certainly the male, was broad-headed and thick-cheeked, whereas the mate was narrow-headed. Similar observations have been made in the Great Lakes region and in the Mississippi Valley. In the North such adult males correspond with the descriptions of *Ameiurus lacustris* (or *nigricans*), a supposed species often referred to *Haustor* and to *Villarius*. The females and all young agree with *Ictalurus punctatus*. In the Mississippi Valley similar breeding males (not always large) have passed as *Ictalurus anguilla*. This sexual dimorphism is general throughout the family (Hubbs, 1940: 209-10). For these reasons we have been treating *Ictalurus punctatus* as specifically identical with "*Ameiurus*" *lacustris* (and with *I. anguilla*). The problem, however, is complicated, because age, individual and geographical variations involve the very characters which distinguish the sexes in mature adults, and many fishermen insist that there are two species of this type.

The largest catfish in Silver Springs when seen at close range on April 5 were judged to weigh 40 to 50 pounds, but the property of water to magnify objects may have deceived the observer. The record weight of locally caught fish is 42 pounds.

Observations made over several years show that these catfish hide during the day in spring caves, heading against the current, and under rocks and logs, and that they come out at night, apparently to feed, and can then be seen with a light in all parts of the spring pond. They are very wary and fast.

In late spring many of these fish migrate into the stream, when they can be seen during the day hiding in groups under low-hanging trees, along with other fish near the bottom.

Some of the larger catfish have odd white spots, like gray hair, on the head, and other marks by which the boat operators can recognize the individuals. The same fish may be seen every day in the same retreat.

Most of these large catfish occur in spring holes downstream from the head spring. A place of particular abundance is called "Catfish Hotel, with running water in every room."

Ictalurus catus (Linnaeus)

WHITE CATFISH

The elimination of *Villarius* (*Haustor*) as a distinct genus, or subgenus of *Ameiurus,* and the synonymizing of this group with *Ictalurus,* throws open the problem of generic separations in the Ameiuridae. The species *catus* (obviously distinct) has been associated systematically with the nominal species based on males of *Ictalurus punctatus.* In all known characters it is obviously intermedi-

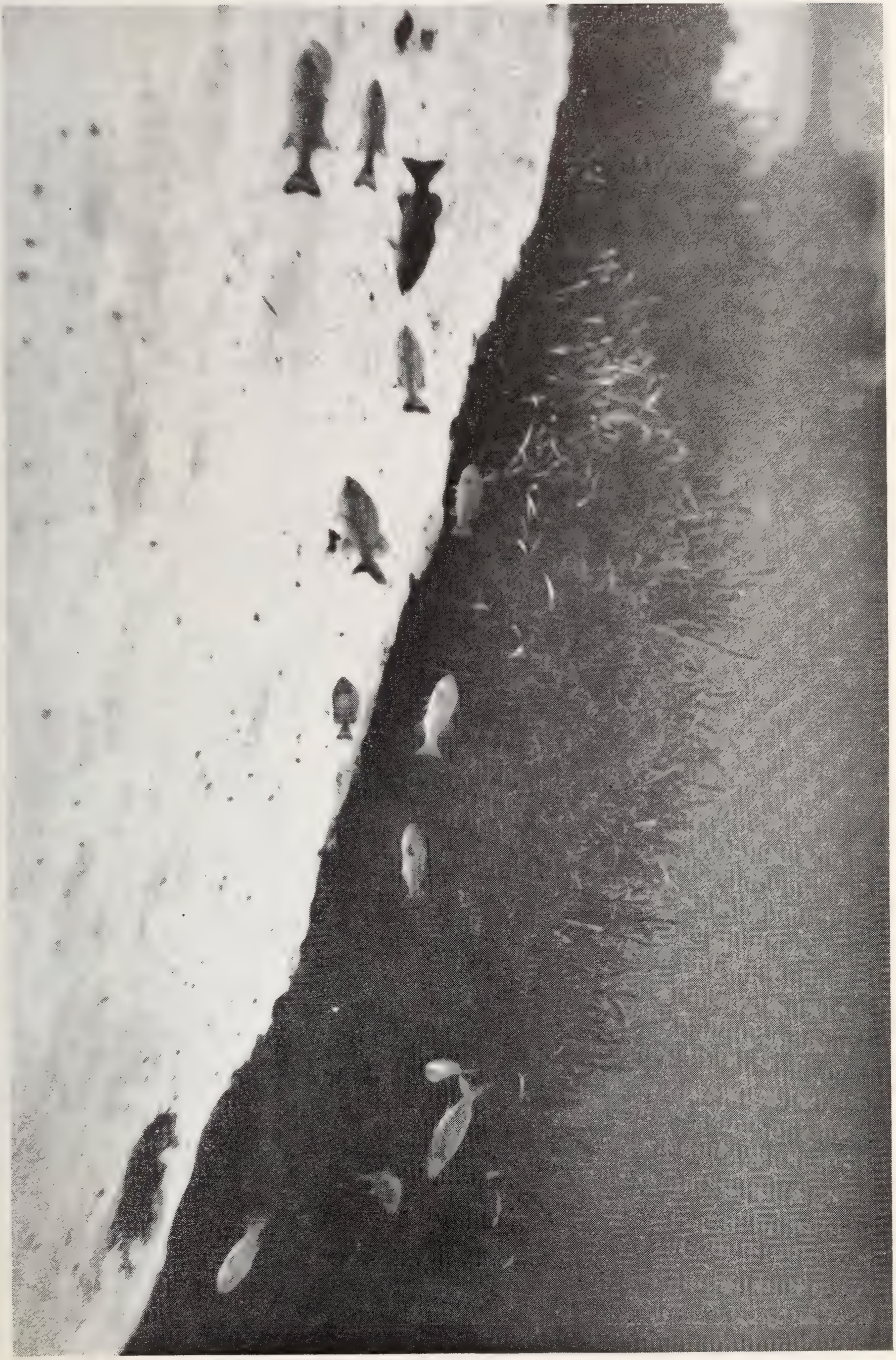

Fig. 3. Largemouth bass (*Huro salmoides*) and sunfish (*Lepomis macrochirus purpurescens* and—one fish to right—*Lepomis microlophus microlophus*) feeding on shrimp freed from floating vegetation in Silver Springs.

Photograph by W. Nase, reproduced by permission.

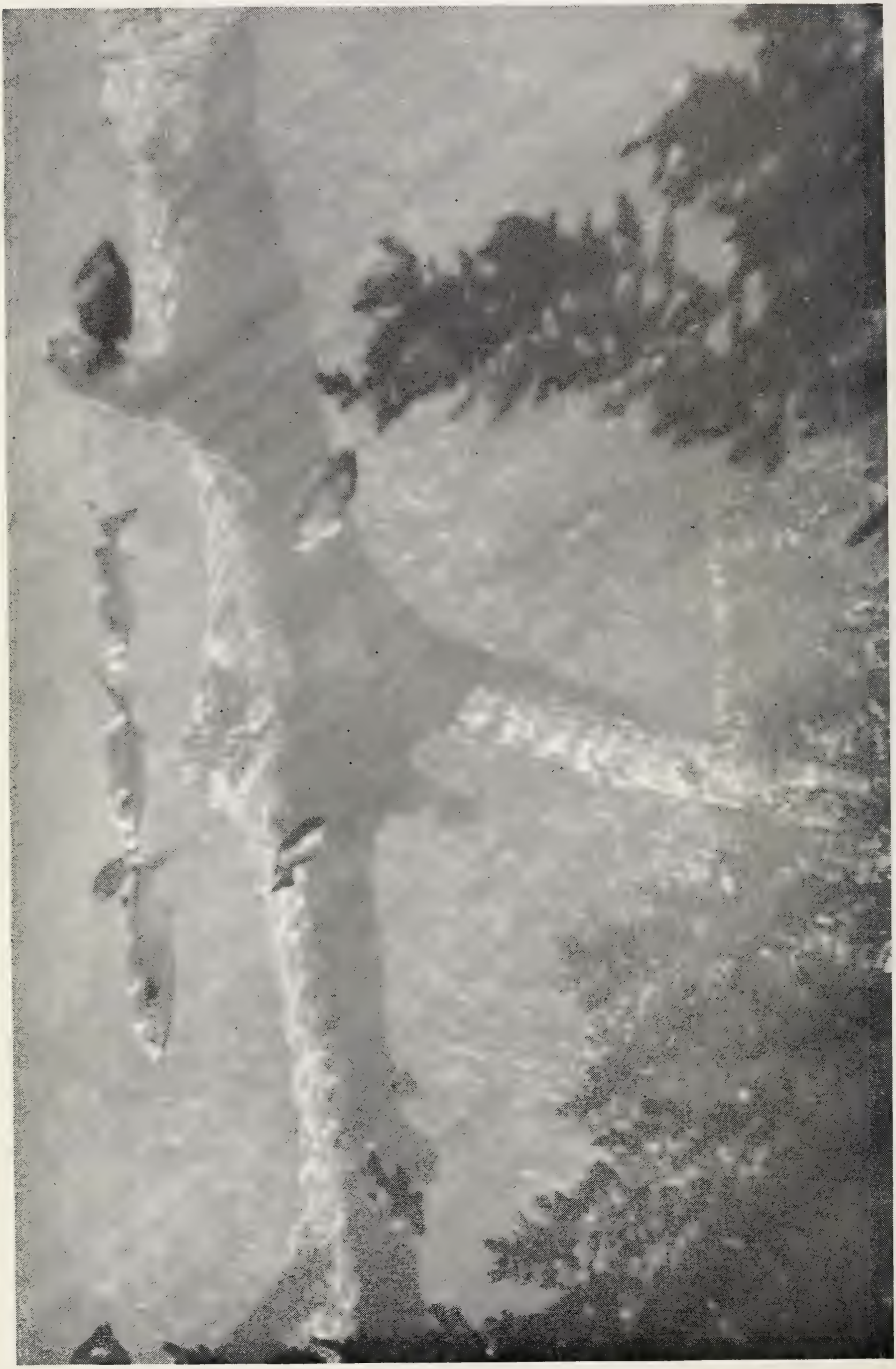

Fig. 4. "Christmas Tree Spring," with striped mullets (*Mugil cephalus*) and eastern bluegills (*Lepomis macrochirus purpurescens*) in plain view. Photograph by E. Ross Allen.

ate between *Ictalurus* and *Ameiurus*. We may either counter convention and convenience by uniting the genera, or we may, rather arbitrarily, put *catus* (and some similar Mexican forms) either in *Ictalurus* or in *Ameiurus*. To preserve a group distinction, "caudal fin more or less deeply forked" as opposed to "caudal fin weakly emarginate, truncate or rounded," it seems best to refer *catus* to *Ictalurus*. The taxonomic and nomenclatorial conclusions regarding the larger catfishes were first indicated by Carr (1936: 80), on our advice. Preserved specimens, collected in 1935 and 1943, seem typical of *catus*.

The white catfish rather belies its name in Silver Springs, where it, along with the other fishes, takes on a dark hue. The larger ones are blackish, like the local adults of *I. punctatus*. Some pairs of catfish, definitely identifiable as *I. catus*, were seen on April 5, 1941, in rock recesses. They were smaller than the breeding adults of *I. punctatus*, and had less deeply emarginate caudal fins. There was agreement, however, in that each pair consisted of a broad-headed male ("*Ameiurus lophius*") and a narrow-headed female (ordinary *catus*).

The catfish which are chummed in swarms into the view of visitors are almost entirely of this species. Along with the "bream" (*Lepomis*, spp.) they feed on bread which is regularly thrown out from the glass-bottom boats. The point of greatest abundance is the already-mentioned Catfish Hotel.

Although they are often quite active by day, the white catfish are also seen at night in shallow water. They have the habit of lying very quietly on the bottom in the mud, or just under a log. In the daytime I (Allen) can swim down and touch them before they seem to be aware of my presence.

Ameiurus natalis erebennus Jordan

SOUTHEASTERN YELLOW BULLHEAD

The bullhead *erebennus* is obviously the southern form of *Ameiurus natalis*, for its differentiae parallel the geographical trends exhibited throughout the family (Hubbs, 1940: 209-10). It remains to be determined whether this variational tendency is sufficiently sharp to warrant retaining *erebennus* as a subspecies.

No bullheads were seen in Silver Springs on April 5, 1941 (they are secretive by day), but one yearling of *A. n. erebennus* is included in the locally obtained collection and 3 adults were collected on August 28, 1935.

This very inactive fish lies on the bottom and therefore little of interest has been noted concerning its habits. Masses of algae have been found in the stomach of this bullhead. At times it can be heard very distinctly grunting under water, for instance when speared.

Mottled catfish are rarely seen in Silver Springs. They may be *Ameiurus nebulosus marmoratus* (Holbrook), but we prefer not to list the species from this locality until specimens have been collected.

ESOCIDAE

Esox americanus Gmelin

BULLDOG PICKEREL

Adults of this species are in the local collection. A small, red-finned *Esox*, probably *americanus*, ranges south to the east coast of Florida. In the western part of the state the little pickerel (referred, unsatisfactorily, to *Esox vermiculatus*) do not have red fins, and other differences exist.

No bulldog pickerel were seen on April 5, 1941, or on any other date, in the spring pond. Nor have they been seen in the main outlet stream. They occur in shallow waters leading off from the outlet, and in adjacent marshes. Those that were collected were picked or scooped up by hand at night, in water less than six inches deep.

Esox niger LeSueur

CHAIN PICKEREL

Larger pickerel, up to 2 feet in length, occur solitarily and rather rarely in Silver Springs, chiefly in the spring of the year. On April 5, 1941, one was seen lying stiff and motionless near the surface in shallow weedy water, close to shore, following the local custom of the species. Its yellowish mid-dorsal stripe was vividly distinct. The color is always bright in Silver Springs. A specimen was collected on August 28, 1935; another on August 4, 1943.

In Silver Springs, as elsewhere, the chain pickerel is ordinarily quiescent, but swims very fast, in short darts, when it does move. One is occasionally seen striking at a smaller fish. When a chain pickerel is disturbed it dives down in the weeds to hide. The flesh is very good eating.

BELONIDAE

Strongylura marina (Walbaum)

BILLFISH

Fish known as "needlefish" or "needle gars" often occur in the spring of the year. None were observed on April 5, 1941, and they usually arrive somewhat later. Obviously this fish is a *Strongylura,* and presumably is *S. marina,* which is the only species along the United States coast that is known to penetrate commonly into fresh waters.

Day and night the billfish swim about on the surface in schools of 2 to 8 fish, often breaking water. They are seen more often downstream than in the head pond. The only specimen that was collected was shot.

ANGUILLIDAE

Anguilla bostoniensis (LeSueur)

AMERICAN EEL

Eels occur in side streams and pools as well as in the head pond and outlet stream.

On account of their secretive, nocturnal habits, the eels are not often seen by day. They occur then in deep water. I (Allen) have scared them out of mud as I walked on the bottom in 30 feet of water. At night they are seen feeding in shallow water on a mud bottom, in which they often disappear when they are disturbed. They are easily caught with a dipnet at night. Some of the specimens have been preserved. The eels have a good flavor, like catfish.

A number of eels have been taken from rainbow snakes (*Abastor erythrogrammus* Latreille) which had caught these fish and taken them onto the bank to swallow.

CYPRINODONTIDAE

Species of this family, known as killifishes, top-minnows, etc., are fairly common along the weedy edges of Silver Springs. Few specimens have been collected, however, and the list given is probably incomplete.

Bangham (1942: 297) listed *Fundulus similis* (Baird and Girard) as from Silver Springs but it is virtually certain that this essentially marine species does not occur here. Dr. Bangham indicates by letter that he was confused in the identification of species of *Fundulus*, that his identifications were not checked and that he preserved no specimens.

Fundulus chrysotus Günther

Golden Topminnow

This is probably the commonest topminnow in Florida. Specimens were collected in August, 1935, in Silver Springs and in nearby lakes.

Fundulus dispar lineolatus (Agassiz)

Southeastern Starhead

This is the topminnow generally known as *Fundulus nottii*. That name, however, along with *Zygonectes guttatus* and *Z. hieroglyphicus*, was originally based on material from near Mobile, Alabama. A study of fresh and preserved material from various points along the Gulf coast indicates that the form ("*nottii*") of the southeastern states and the peninsula of Florida does not occur about Mobile or elsewhere to the westward, and that only one form, exhibiting striking differences with age and sex, occurs about Mobile. This is the type commonly called *F. guttatus*, but in view of the synonymy as drawn up by Garman (1895: 120-21), under *Zygonectes nottii*, we must treat *Z. guttatus* (with *Z. hieroglyphicus*) as a synonym of *Fundulus dispar nottii*. The form commonly called *nottii* will therefore need another name, and may be called *Fundulus dispar lineolatus* (Agassiz). This application of the names *nottii* and *lineolatus*, on our advice, was given first notice in the key to Florida fishes by Carr (1936: 82). Both *nottii* and *lineolatus* are now provisionally referred to *Fundulus dispar*, because it appears that they are the terminal elements in a graded chain of forms ending with *F. dispar dispar* in the North.

Specimens of *F. d. lineolatus* were obtained in Silver Springs on August 28, 1935.

Chriopeops goodei (Jordan)

Redtail Killifish

Specimens of this attractive fish were collected in Silver Springs and in a nearby lake on August 28, 1935.

Leptolucania ommata (Jordan)

Ocellated Killifish

This minute species, with eye-like spots, is not yet reported from Silver Springs proper, but almost surely occurs in marginal vegetation. Seven specimens were seined in a nearby lake on August 28, 1935.

Jordanella floridae Goode and Bean

Flagfish

This beautiful cyprinodont occurs in the shallow water of Silver Springs, among "grasses." One preserved specimen is at hand.

Lucania parva (Baird and Girard)

Rainwaterfish

Several examples of this plain-colored killifish were collected at Silver Springs on August 28, 1935. Another was obtained on August 4, 1943.

POECILIIDAE

Gambusia affinis holbrookii (Girard)

EASTERN MOSQUITOFISH

This little fish, effective in mosquito control, is rather common along the weedy shores of Silver Springs, but it is less abundant than it was formerly. Black-spotted individuals occasionally occur. Series were collected on August 28, 1935, and August 4, 1943.

Heterandria formosa Agassiz

LEAST KILLIFISH

This tiny live-bearer, once regarded as the smallest of all vertebrates, is well represented in the local collection of August 30, 1935.

Mollienisia latipinna LeSueur

SAILFIN MOLLY

The local form of *Mollienisia* is typical of *M. latipinna*. The number of dorsal rays (Table I) is average for the species, partaking neither of the increase characteristic of the salt-water types of Pensacola Bay and Key West nor of the decrease that marks the races of Georgia and the Carolinas.

TABLE I

DORSAL RAYS IN MOLLIENISIA LATIPINNA FROM SILVER SPRINGS

	Number of rays			
	13	14	15	Average
Number of Specimens	5	19	1	13.84

This popular aquarium fish is still rather common about the remaining marshy edges of Silver Springs, but it is not as abundant as it was formerly. The active, sail-finned males, with the blue reflections resplendent in the sunlight, always attract attention as they strut about and circle the females in courtship. They keep up this activity all day, but become quiet at night, when they stay in very shallow water. One male in the preserved series (of aquarium stock?) is almost solid black, and spotted ones are seen.

APHREDODERIDAE

Aphredoderus sayanus (Gilliams)

PIRATEPERCH

The occurrence of this weird, pugnacious little fish at Silver Springs is attested by the collections. It is found only in side streams and pools, under water lettuce.

PERCIDAE

Hadropterus nigrofasciatus Agassiz

CRAWLABOTTOM

The confused nomenclature of the etheostomatines of the *Hadropterus nigrofasciatus-scierus* group is under much needed review. This is one of the few types of darter that penetrates the peninsula part of Florida.

Archie F. Carr, Jr., informed us that he knew from observation that Silver Springs harbored a species of darter, though no specimens had been obtained. Consequently we watched particularly for darters during the trip of April 5, 1941, and on shell-littered shoal bottom saw a few which were almost surely referable to *Hadropterus nigrofasciatus*.

What is probably the same darter is very common on rock ledges and other rock and clay bottom, in the rather swift deep current of the springs. One rock in only 4 feet of water, downstream from South Beach, is a favorite habitat.

CENTRARCHIDAE

Micropterus dolomieu dolomieu Lacépède

NORTHERN SMALLMOUTH BASS

There is yet no proof that the smallmouth bass inhabits Silver Springs, but there is some evidence that it has penetrated into these waters, which would seem to be suitable to it as to the largemouth. A few years ago some smallmouths were planted in Lake Weir which has been connected by canal with Oklawaha River about 20 miles away. Since the planting and the connection were made, several persons have reported seeing smallmouths in the Spring. On April 5, 1941, Hubbs saw a bass with darkened scales that may have been a smallmouth bass, or an unknown Florida species, and Boyd W. Walker saw two or three fish which he took to be *M. d. dolomieu*. The identifications, however, were not all certain.

Huro salmoides (Lacépède)

LARGEMOUTH BASS

The classification of the largemouth bass has not received the revisionary study which has been accorded the species and subspecies of *Micropterus* (Hubbs and Bailey, 1940). It is therefore not possible at this time to name more precisely the form of largemouth bass that occurs in Silver Springs. It is an intensely marked fish, with the black band on the caudal fin rather conspicuous. The dark band on the body tends to be broken up into blotches or short vertical bars.

Largemouth bass (Fig. 2), of small to large size, are common at various depths in Silver Springs, and prove to be among the most interesting of the fish to the visitors. The largest ones, some of which would seem to weigh as much as 12 pounds or more, hide under floating plants, water lettuce, logs, tree branches, and similar shelter.

The bass in Silver Springs feed on fish and crayfish, and seem to be particularly fond of *Palaemonetes paludosa* (Gibbs), localy known as "fairy shrimp" (see Fig. 3). Some, becoming very tame, follow me (Allen) as I swim along with bunches of *Ludwigia* pulled up from the bottom. They follow as close as 2 feet, to snap up the shrimp as they are washed out of the plants. The bass readily take frogs that are thrown into the middle of the pool.

Chaenobryttus coronarius (Bartram)

WARMOUTH

As shown by Harper (1942: 50) the proper specific name of the warmouth is *coronarius* rather than *gulosus*.

Few warmouths were observed among the thousands of centrarchid fish seen on April 5, 1941, presumably for the reason that this species is common only around the margin, in weeds and around logs, stumps and like cover. It is more commonly seen at night than by day. Specimens have been collected.

Lepomis punctatus punctatus (Cuvier)

EASTERN STUMPKNOCKER

This form is accorded trinomial nomenclature because *punctatus* and *miniatus* have been found to intergrade completely between the Mississippi River and the Florida peninsula. This nomenclatorial conclusion has been adopted by Carr (1936: 85). We follow Bailey (MS) in referring all the common sunfishes to a single genus, *Lepomis*.

The interesting and true vernacular, "stumpknocker," refers particularly to this species, and we urge its adoption as the "book name."

The eastern stumpknocker is characterized by the numerous small blackish spots on its light-colored sides. In the water, however, these spots are less conspicuous and diagnostic than are the bright silvery, creamy, or rosy margins along the soft dorsal and caudal fins. Most of the stumpknockers stay during the day in only moderate depths, swimming leisurely over the weeds near the bottom. As the diving bell nears the surface stumpknockers swim against the glass windows, as though curious. At night they come inshore, where they may be caught easily. They also come inshore to spawn in slight excavations near the edge of the pool, as observed on April 5, 1941. Stumpknockers were also observed nesting in Silver Springs during June, 1943. Most of the redds were located in groups on hard bottom, of white sand or snail shells. The guarding parents are faithful, deserting their nests only when considerably disturbed.

Lepomis auritus (Linnaeus)

REDBREAST SUNFISH

No valid grounds have been found for the separation of *solis* as a distinct southern subspecies, or specific representative of *auritus*.

This is one of the scarcer species of sunfish in Silver Springs. Only a few adults were seen on April 5, 1941. However, there is no doubt as to its occurrence here, for the observations were clear-cut and 3 preserved specimens are at hand.

Lepomis macrochirus purpurescens Cope

EASTERN BLUEGILL

The modern use of the name *macrochirus* for the bluegill dates from Hubbs (1935: 2-5). The form indigenous along the Atlantic coast from the Carolinas to the Florida peninsula is quite distinct from the common bluegill, *L. m. macrochirus* (which ranges into western Florida). In young and half-grown stages it differs from the western form in having reddish fins (fading with age), and in the broader, more even bars and higher fin spines (as shown in the figure by Fowler, 1940: 14, fig. 19). These characters persist in the adult but become less obvious with age. The adults are more purplish (this is particularly true of the breeding males), and frequently have a cream-colored bar across the nape, connecting with a large blotch or wide bar of the same color across the opercular region (Archie F. Carr, Jr., tells us that the "crackers" insist that the bluegills so marked are a different kind, and "eat better.") The anal soft rays, particularly in Florida and southern Georgia, average more numerous than in typical *macrochirus* (more often 12 than 11, rather than typically 11, rarely 10 or 12). The "Georgia bluegill" or "Georgia brim," as it is known to fish culturists, retains these characters where is has been introduced, as in Texas, and in the Yaqui River system of Sonora. It proves to be a larger, faster-growing and more resistant fish than the common bluegill. It is no doubt a genetically distinct and recognizable form. It may even prove specifically different.

The characters here ascribed to *L. m. purpurescens* were evident in the many bluegills seen in Silver Springs on April 5, 1941. It is the dominant sunfish in these waters. The bluegills (Figs. 2-4) occur more often in the open water and in the deeper spring holes than do the other species. They have been trained to come to food (bread) so as to be easily seen in large numbers by the visitors. Next to the catfish, they are probably the most conspicuous fish in the Springs.

Lepomis microlophus microlophus (Günther)

EASTERN SHELLCRACKER

The application of the specific name *microlophus* to this sunfish is based on the discussion by Hubbs (1935: 5-9). The vernacular, "shellcracker," is particularly appropriate and pleasing. This is the largest sunfish in Florida, and the most highly regarded by anglers. Although it feeds largely on snails, it may be caught on worms.

The shellcracker, recognizable by the red "ear-spot," is a common species in Silver Springs, in both deep and shallow water. On April 5, 1941, most of those seen were large adults. One is shown in Fig. 3. Some of the males, in water of considerable depth, were guarding nests which were conspicuous, bowl-shaped depressions in dense stands of the coarse *Sagittaria*. They are faithful guardians. Several adult specimens from the Springs have been preserved.

Enneacanthus, species

Specimens of *Enneacanthus* have been collected but none have been examined by the senior author to make sure of the specific identification. *E. obesus* and *E. gloriosus* both occur in Florida.

Pomoxis nigro-maculatus (LeSueur)

BLACK CRAPPIE

The use of the name *P. nigro-maculatus* in place of *P. sparoides* was validated by Bailey (1941).

No crappies were seen in Silver Springs during the observations of April 5, 1941, but an adult specimen speared by Allen is in the University of Michigan collection, and another taken May, 1936, is in the National Museum.

ELASSOMIDAE

Elassoma evergladei Jordan

EVERGLADES PYGMY SUNFISH

This species, one of the smallest of all the spiney-rayed vertebrates, is represented in the preserved collection at hand from Silver Springs. Another specimen, of 13 mm., was taken on August 29, 1935.

It is one of the species which frequent dense weeds in shallow water.

Mugil curema Valenciennes

WHITE MULLET

A mullet labelled as collected in Silver Springs by Hildebrand and Allen on August 30, 1935, is an example of this species. In general the white mullet is less common in fresh waters than is the striped mullet, but it is known to penetrate at times far inland (as in Texas). This white mullet may have been a stray, or may have been mislabelled. The record needs confirmation.

Mugil cephalus Linnaeus

STRIPED MULLET

Most if not all of the mullets that now occur in Silver Springs, almost certainly all of the larger adults, are of this species (Figs. 1, 2 and 4). The dark stripes along the scale rows are evident in life. The depth of the body was seen to vary greatly. Many of those observed on April 5, 1941, were feeding. They shook their heads from side to side as they browsed over the rock bottom and particularly up the broad blades of the *Sagittaria.* As they continually feed in this fashion they expel clouds of dirt from their mouths.

These very active fish travel in schools of about a dozen, most commonly in the deep pools. They frequently jump out of water. They are also active at night but apparently do not feed then. They are not bothered by other fish. Extremely large mullet are never seen in Silver Springs.

ATHERINIDAE

Labidesthes sicculus vanhyningi Bean and Reid

SOUTHEASTERN BROOK SILVERSIDE

This is a rather poorly defined geographical subspecies. One character is the large eye.

No brook silverside were observed on April 5, 1941, but there are specimens in the local collection. It is to be watched for at the surface.

ACHIRIDAE

Trinectes maculatus fasciatus (Lacépède)

SOUTHERN HOGCHOKER

The generic and the specific nomenclature of this common American sole were treated by Hubbs (1932). The name for the species should stand as *Trinectes maculatus* (Bloch) rather than as *Achirus fasciatus* Lacépède. The northern form, *T. m. maculatus,* is distinguished from the Gulf of Mexico subspecies (commonly called *browni*) chiefly in having the blind side of the adult conspicously spotted. The proper subspecies name for the southern form could not be determined until a good series of topotypes of *Achirus fasciatus,* from Charleston, South Carolina, became available. This desideratum was adequately supplied by E. Milby Burton of the Charleston Museum. Some Charleston specimens are more or less weakly spotted on the eyeless side, but the majority are unpigmented on this side. *Achirus fasciatus* was therefore based on intergrades, but on a population approaching the southern form much the more closely. For this reson the name *fasciatus* is applied to the southern subspecies.

Another feature of *T. m. fasciatus* is its frequent occurrence in lakes and streams far inland from the saline or even tidal influence of the sea. It is therefore not at all surprising to find that this sole occurs in Silver Springs. Several were seen here on April 5, 1941, by members of the American Society of Ichthyologists and Herpetologists, and there is one specimen in the preserved collection. It was caught by hand at a depth of 25 feet, in Big Spring.

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NEEDLE RUSTS OF PINE TREES IN FLORIDA CAUSED BY COLEOSPORIUM SPECIES

George F. Weber
Agricultural Experiment Station, University of Florida

Needle rusts are commonly found and observed in Florida on the different species of pines so abundant in the State. The brilliant orange color of the maturing aecia on the green pine foliage frequently attracts attention to the rusts caused by *Coleosporium* spp. No one has ventured a theory as to the origin of these needle rusts, but it is thought that they are indigenous to Florida. Davis (1913) has shown how a certain species was probably introduced into Wisconsin.

Published information concerning these rusts is not plentiful, and as indicated by Dearness (1939) and Hedgecock (1939a) it is not entirely usable either by the amateur or the professional, unless the latter is an expert. Definite identification in the field of all the fungi causing these needle diseases is almost impossible. There are a number of species of *Coleosporium* occurring in Florida. Being similar in their manifestations, and as a rule only identifiable by microscopic examination, in this paper they will be treated as a group in relation to the diseases which they cause, but separately with respect to their taxonomic characters.

The information here presented has been obtained from observations and collections made by the author and associated co-workers over almost a score of years in Florida, and from the literature, to which Hedgecock and his collaborators (1913-1939) have been the principal contributors. Dr. Hedgcock has accompanied the author and his colleagues on some of their collecting trips.

THE DISEASE

Needle rusts have been collected in Florida in widely separated localities. From the available information one suspects their occurrence to be more or less general over the entire state wherever pine trees are growing. There are certain large areas in south Florida, possibly 30 miles across, where no species of pine occurs. South of a line drawn from Ft. Myers to Palm Beach, *Pinus clausa* and *P. caribaea* are the only native pines present. In general, needle rust disease seems to be scarcer toward the tropics and more abundant northward, though it has been reported by Stevens (1917) from Puerto Rico. In southern Florida, judging from scattered collections, it is rather uncommon, but throughout the central and northern parts of the state needle rust is very plentiful. Certain species of *Coleosporium* have been collected on a half dozen species of *Pinus,* and one or more species of the fungus can be found infecting pines wherever these trees occur in Florida.

At present the following eight species of pine are considered indigenous to Florida: *Pinus australis* (longleaf pine), *P. caribaea* (southern slash pine), *P. clausa* (sand pine), *P. echinata* (shortleaf pine), *P. glabra* (spruce-pine), *P. palustris* (northern slash pine), *P. serotina* (pond pine or black pine), and *P. taeda* (loblolly or oldfield pine). Reports of collections of diseased needles by Hedgcock (1933, 1939b) show that each of the pines has been found infected by one or more *Coleosporium* species. In all of the collections made by Hedgcock and by the author and his associates, only a single species of *Coleosporium* has been found infecting *Pinus clausa;* but this same fungus has also been found in Florida on *P. australis*, *P. caribaea*, *P. glabra, P.palustris, P. serotina*, and *P. taeda*.. In contrast, another of the needle rusts, which was found on *Pinus glabra* near Gainesville, Florida, and described by Hedgcock and Hunt (1917g), has never been found anywhere else in the world, although it still occurs annually at the type locality, and has there since been found on *Pinus taeda.*

The pines are more or less infected by one or more of these fungi wherever they grow. The disease may be scarce, as intimated by Graves (1914), or very prevalent even on commercial plantings as reported by Guterman (1935).

All of the needle rusts occurring in Florida are heteroecious. The pycnia and aecia are found on *Pinus* spp., and the uredinia and telia on alternate hosts which are usually broad-leaved plants, the majority of them belonging to the *Carduaceae*.

Boyce (1938) stated that he considered needle rusts most active (or severe) on young pine trees in the seedling and sapling stages. Hubert (1931) stated that young seedlings are sometimes severely infected and suffer some stunting but that death of the plant due directly to attacks of the disease has not been noted. Rankin (1918) noted that the needle rusts occasionally caused defoliation. In what follows nursery stock is taken as including plants 1 year old or less; seedling ranges to 3 feet high, a sapling to 4 inch diameter, and a tree is more than 4 inches in diameter. Observations by the author in Florida have shown that seedlings are certainly more heavily infected than saplings or trees of the same species. The disease has been found occasionally in nursery stock but not in sufficient quantity to be recorded as more than a trace. This is probably accounted for by the fact that the few nurseries visited were located in extensively cultivated areas where the fungus did not reproduce plentifully, possibly because of the lack of alternate hosts. Also, artificial protection (such as cloth covering and fungicides) may have been a contributing factor. The young plants in nature, less than 1 year old, are seldom more than a third as tall as nursery stock and have seldom been found infected. In contrast, however, seedlings between 1 and 2 feet tall are frequently very heavily infected in the vicinity of Gainesville. Seedlings of *Pinus taeda* growing in a location very favorable for the development of the disease have been killed over a two year period. Others were very badly stunted by the disease. Seedlings of *Pinus australis* between 1 and 2 feet tall in this vicinity have been found in the spring showing the rust infection on 95% of the needles which resulted in no serious effects during the summer, other than a possible temporary stunting. Continued observations during the following spring of these identical seedlings showed no infection. This area was burned in the interim and all infections on the pine and alternate host were apparently destroyed. Seedling infection is widespread, commonly found and occasionally severe enough to be considered of economic importance. The disease on saplings is seldom of importance although almost every plant under ten feet in height that possesses low spreading branches shows some infection. The high-headed saplings and pine trees show little needle rust, and under the most favorable circumstances almost none.

Symptoms.—There are several species of *Coleosporium* that cause infection of the needles of pine trees. The symptoms produced are generally very similar; slight exceptions to this statement will be mentioned only when pertinent.

The principal symptom that characterizes the disease is the appearance of yellow- to orange-colored areas, several millimeters to several centimeters in length, located anywhere on the needle from fascicle sheath to the tip. The infection is less frequent at the apex than elsewhere. A single infection apparently causes one colored band across the otherwise healthy green leaf. Several such etiolated areas may occur on a single needle, caused by infections by more than one species of the fungus. On a particular host the color of the infected tissue is consistently the same for each of the *Coleosporium* spp. There are slight differences in this respect between hosts, and also between different fungus species infecting the same host. These colored areas on the needles are conspicuous and easily seen but cannot be considered proof of rust infections unless upon closer examination pycnia or aecia of the fungus are found. These structures not only indicate that the infection has been caused by a *Coleosporium* sp., but are safe diagnostic characters for determining the exact *Coleosporium* sp. involved. The pycnia may appear on pine needles in central Florida anytime after early January, being most common during the last half of February. They are small, circular to oval, slightly raised, rounded, smooth surfaced, reddish-orange to black areas, 1-4 mm. in diameter. The areas may be in single, continuous or intermittent, irregular lines, in several parallel short lines, or in somewhat irregular clusters on the yellowish areas, all usually on one side of the needle. The pycnia are followed in appearance by the aecia, which become evident three to six weeks later in central Florida. The aecia break through the epidermis of the leaf opposite the pycnia. This stage of the fungus is very conspicuous. The aeciospores contained within the peridial walls are bright orange in color. The peridial walls are several millimeters in height. The aecia vary considerably among the *Coleosporium* spp. in size, color and shape, but each species is rather uniform on the various *Pinus* spp. The symptoms found on the pine needles, including the color of the spot and the size, color and location of the pycnia and aecia, are diagnostic characteristics of the needle rust diseases.

The symptoms of the disease on the alternate hosts are much less conspicuous. The uredinia and telia are similar and appear as inconspicuous yellow, cushion-like areas on the leaf surface of herbs and weeds. These infections cause yellow areas to appear on the foliage and frequently result in the death of these plants.

THE FUNGI

Taxonomy.—Common names of the diseases found in literature are leaf rust, needle rust or pine needle rust.

The genus name *Coleosporium* was first used by Leveille in 1847 in reference to the fungi causing needle rust. Since that time new species have been discovered and named. Saccardo (1887-1924) lists 54 described species. Hubert (1931) suggests about 80 and Ludwig (1915) reports 25 species. Arthur (1934) published descriptions of 20 *Coleosporium* spp. on the genus *Pinus* in the United States and Canada. Hedgcock after examining all available collections verified 23 species for the United States; his earlier published key (1928) contains 18 for this area. Boyce (1938) reports 16 species, and Rhoads (1918) presents notes on 14 species. After carefully checking all authentic reports of Florida collections supplemented by our staff collections it is found that there are 10 *Coleosporium* spp. in the state. They are as follows:

TABLE I

List of Pine Needle Rusts Found in Florida, Including Name of Fungus, Pine and Alternate Hosts

Fungus	Hosts	
	O, I	II, III
Coleosporium apocynaceum Cke.	*Pinus australis* *Pinus palustris* *Pinus taeda*	*Amsonia ciliata*
Coleosporium delicatulum (A. & K.) H. & L.	*Pinus australis* *Pinus palustris* *Pinus serotina* *Pinus taeda*	*Euthamia caroliniana* *Euthamia leptocephala* *Euthamia minor*
Coleosporium elephantopodis (S.) Thum.	*Pinus australis* *Pinus glabra* *Pinus palustris* *Pinus serotina* *Pinus taeda*	*Elephantopus carolinianus* *Elephantopus elatus* *Elephantopus nudatus* *Elephantopus tomentosus*
Coleosporium heterotheca Hedgc.	*Pinus australis*	*Heterotheca subaxillaris*
Coleosporium ipomoeae (Schw.) Burr.	*Pinus australis* *Pinus palustris* *Pinus serotina* *Pinus taeda*	*Colonyction aculeatum* *Ipomoea carolina* *Ipomoea pandurata* *Ipomoea pes-capreae* *Ipomoea speciosa* *Ipomoea triloba* *Pharbitis barbegina* *Pharbitis cathartica* *Pharbitis hederacea*
Coleosporium laciniariae Arth.	*Pinus australis*	*Laciniaria chapmanni* *Laciniaria elegans* *Laciniaria graberi* *Laciniaria gracilis* *Laciniaria laxa* *Laciniaria pilosa* *Laciniaria scariosa* *Laciniaria tenuifolia*
Coleosporium minutum H. & H.	*Pinus glabra* *Pinus taeda*	*Adelia ligustrina*
Coleosporium solidaginis (Schw.) Thum.	None in Florida	*Aster puniceus* *Chrysopsis scabrella* *Solidago brachyphylla* *Solidago chapmannii* *Solidago fistulosa* *Solidago puberula* *Solidago rugosa* *Solidago sempervirens* *Solidago stricta*
Coleosporium vernoniae B. & C.	*Pinus australis* *Pinus clausa* *Pinus echinata* *Pinus glabra* *Pinus palustris* *Pinus serotina* *Pinus taeda*	*Vernonia augustifolia* *Veronia blodgettii* *Vernonia flassidifolia* *Vernonia oligantha* *Vernonia ovalifolia*
Coleosporium viguierae D. & H.	None in Florida	*Verbesina lacinata*

It would be very helpful to include here a description of each of the 10 *Coleosporium* species occurring in Florida, but space does not permit. Detailed descriptions of the fungi with synonyms, host and geographical range are published by Arthur (1934); Hedgcock (1913, 1916, 1939a); Hedgcock and Long (1913, 1917); Hedgcock, Bethel & Hunt (1919); Hedgcock, Hunt & Hahn (1920); Rhoads, et al (1918); and Weir and Hubert (1916).

As indicated in the table above no authentic specimen of either *Coleosporium solidaginis* or *C. viguierae* has been found on any pine in Florida. The 10 species found in the state are reported from the alternate hosts. The data accumulated through artificial inoculations by Hedgcock and Hunt (1917a-1933) show that the range of host plants is limited to certain families and genera. Consequently the identification of rusts when either the uredinia (II) or telia (III), or both are present is reliable.

Arthur's key (1934) to rusted alternate hosts, abridged to include only Florida species, and slightly revised, is as follows:

Alternate hosts belonging to family Oleaceae—*Coleosporium minutum* H. & H.
Alternate hosts belonging to family Apocynaceae—*C. apocynaceum* Cke.
Alternate hosts belonging to family Convolvulaceae—*C. ipomoeae* (Schw.) Burr.
Alternate hosts belonging to family Carduaceae
    Tribe Vernonieae
        Genus—Vernonia—*C. vernoniae* B. & C.
        Genus—Elephantopus—*C. elephantopodis* (S.) Thum.
    Tribe Eupatorieae—*C. laciniariae* Arth.
    Tribe Astereae
        Genus—Euthamia—*C. delicatulum* (A. & H.) H. & L.
        Other genera—*C. solidaginis* (S.) Thum. (including *C. heterothecae* H. & H.)
    Tribe Heliantheae—*C. verbesinae* D. & H.

The above key is based entirely on the infected alternate host and urediniospores produced thereon. It contains *Coleosporium solidaginis, C. verbesinae* and *C. heterotheca* none of which have been found to produce the peridermium stage, or pycnia and aecia, on pines in Florida. Arthur (1934) includes the latter under *C. solidaginis*.

On the other hand only 7 *Coleosporium* spp. have been definitely identified as parasitizing *Pinus* spp. in Florida. The various diseases on pines show the pycnia (O) and aecia (I) stages of the different fungi. These stages are very consistent and uniform for each fungus on each host and, except to the expert, are likewise quite similar to each other. Hedgcock (1928) has worked out a key by which he is able to distinguish the species in the United States. Herewith is a revised and abridged version of the part of this key containing *Coleosporium* spp. on pine needles, applicable only to Florida.

I. Dehiscence of the peridium irregularly apical and longitudinal.
  A. Aecia very conspicuous usually in single extended rows.
    1. Aecia irregularly flattened rhomboidal, pycnia orange-rufous, auburn or chestnut colored....................................*Coleosporium vernoniae* B. & C.
    2. Pycnia olivaceous black to brownish black.
      Coleosporium elephantopodis (Schw.) Thum.
  B. Aecia small and inconspicuous, usually clustered or in short rows, pycnia olive to olivaceous black.
    1. Pycnia usually in single extended line.
      Coleosporium ipomoeae (Schw.) Burr.
    2. Pycnia usually clustered.............................*Coleosporium laciniariae* Arth.

II. Dehiscence of the peridium circumscissile.
  A. Aecia large and conspicuous on yellow chlorotic areas. Pycnia hazel to chestnut brown..*Coleosporium apocynaceum* Cke.
  B. Aecia small and inconspicuous.
    1. On reddened chlorotic areas, pycnia orange chrome to English red.
      Coleosporium delicatulum (A. & K.) H. & L.
    2. On yellowish chlorotic areas, pycnia tawny to buckthorn brown.
      Coleosporium minutum H. & H.

This key is workable for Florida needle rusts after a little experience in the field with color variations and other factors.

Morphology.—These rusts are all of the Eu-type in which the O, I, II, III stages are present during each season. They are heteroecious in host relationship, with the pycnial and aecial stages appearing on the pine needles, and the uredinial and telial stages appearing on various herbaceous dictoyledonous plants.

The pycnia are subepidermal, mound-shaped to flat, oval to linear, paraphysate, dehiscing by a slit. They may be located in lines continuous or intermittent, or in several short parallel rows, or in groups. In color they vary considerably, from yellow and orange to olive or blackish; and they range from 0.5 to 2.0 mm. in length.

The aecia are foliicolous, amphigenous, hypophyllous or epiphyllous, erumpent, with colorless peridium prominent and of various shapes and sizes; dehiscing slit is longitudinal at crest in smooth or rough line or circumscissile. The aeciospores are ellipsoidal or globoid, with verrucose colorless walls. The contents are usually orange, and en masse cause the aecia to be conspicuous because of their bright color.

The uredinia are erumpent, pulverulent, without peridia, round or oval, raised, usually small, orange or yellow when fresh. On either surface of the leaves, usually more numerous on lower surface. Urediniospores ellipsoid to globoid or obovate, catenulate, of various sizes, with colorless thin walls, finely or strongly verrucose.

The telia are indehiscent except through weathering, waxy, or gelatinous according to Cummins (1938), becoming gelatinous upon germination, usually on lower surface of leaves, scattered or clustered, and of variable size and color. The teliospores are sessile or obscurely catenulate, one-celled, cylindric, thin, smooth, the colorless walls more or less thickened at round or acute ends.

These rusts are all obligate parasites, requiring both of the hosts to complete their lie cycle in any single season. They cannot be grown on sterile nutrient decoctions, but can be cultured on either host in controlled environments such as greenhouses. The aeciospores and urediniospores germinate in water when mature, especially in the presence of host materials, and are capable of causing infection within 24 hours under conditions favorable for their growth. The teliospores germinate in place, freeing the basidiospores in abundance. These spores are small and easily carried by air currents to the pine.

Pathogenicity: It is primarily through the extensive inoculation experiments conducted by Hedgcock (1933) and Hedgcock and Hunt (1917a, c, d, f, g), that we know of the extensive host range of these various species of rust. The data definitely show that these fungi are highly pathogenic on one or more of the native pines of Florida. Likewise they have shown that the uredinial and telial stages of a single species are found on as many as nine herbaceous hosts in the state. These experiments were usually verifications of observational data, substantiated by collections in the field, although the inoculations have extended the host range beyond those found in nature.

THE HOSTS AND FUNGI IN RELATION TO THE DISEASE

The seasonal development of the disease is dependent on the proximity of the hosts. It should also be borne in mind that the advance of spring in the various regions of the United States from South to North influences markedly the dates of appearance of the disease. Hedgcock (1939b) states that the pycnia of *Coleosporium* species appear in central Florida in December and mature in January to February and that they precede the aecia by at least a month. The writer has not determined the limits of early pycnia appearance, but on February 2, 1941, aecia were collected on *Pinus taeda* a few miles from Gainesville that already had completely shed their aeciospores. During the previous year their first appearance was about 5 to 6 weeks later. Cool weather retards their development. In relation to each other, however, certain ones are always the first to appear and others are consistently later. The dates of appearance of the first and the last may cover a period of 6 to 8 weeks from February 1 to April 1. The aeciospores are shed during this period and disseminated by the wind and rain to plants in the immediate vicinity. The herbaceous hosts of several species usually show new growth during later January. Many of these alternate host plants continue growth in the rosette stage throughout the winter and have been found showing mature uredinia spores every month of the year. Thus they may continue to develop during the entire season without utilizing the stages on pine. This condition was found by Maines (1916) to exist north of the Ohio River. The uredinial stage continues during the summer and the telial stage develops on the older foliage in summer and fall early enough to infect the needles of the young pine seedlings. This infection develops slowly during the fall and winter. The pycnia appear in January and February on these infections followed by the aecia in February and March. The fungus overwinters in several ways, namely (a) on the pine needles infected in the summer and fall, (b) in the telia on the alternate host producing basidiospores in the spring, and (c) in the uredinia on the alternate host where spores are produced throughout the year. Eriksson (1921), in addition to these, suspects a mycoplasm symbiosis.

The infected herbaceous alternate hosts are the source of the inoculum in the summer and fall with which the pines are infected. The sources of the inoculum in the spring by which the herbaceous hosts are inoculated are the aecia on the pine needles. The aeciospores are not capable of reinfecting the needles of pines, but must infect the herbaceous plants. The teliospores, upon germination produce basidiospores. Basidiospores cannot reinfect the herbaceous host upon which the teliospores were produced but can infect only the pine. The urediniospores very readily reinfect the herbaceous host upon which they were produced. The spores produced on each of the hosts are disseminated by the wind. It is known that the aeciospores may withstand adverse conditions and over extensive periods travel long distances before losing their viability, whereas the basidiospores are delicate and short-lived and are disseminated usually less than a mile before dying.

The time of infection of both hosts is very shortly after the first mature spores are produced. The aeciospores may infect the herbaceous hosts any time during February, March and April and these plants may suffer additional infection by urediniospores which are produced on these plants after a 2 to 3 weeks incubation period throughout the summer. The basidiospores as a source of inoculation cause infection primarily through late summer and fall. Infection of the herbaceous hosts in all instances is direct; that is the germination tubes of the spores, after a short period of growth, grow directly through the epidermis, although stomatal entrance may be possible. Johnson (1934) observed no tropic responses. Penetration of the pine needle is generally considered to take place through the stomata.

The production of aecia and aeciospores may occur several months after infection, appearing usually scattered, but found by Spaulding (1917) to be as many as 20 per needle. They appear only in the spring following infection of the previous year. The production of uredinia occurs less than a month after infection of the alternate host by aeciospores. Usually the fungus does not extensively invade the host tissue and only small areas of needles show any yellowing, resulting apparently from invasion and not from toxic effects as produced by many parasites.

CONTROL

The primary factor in control of the disease on pines would be the elimination of the herbaceous alternate host. This can most easily be done by planting pine seed beds in cultivated fields as far as possible from woodlands, roadsides and fence rows where alternate hosts usually grow. Ordinarily the protection given seed beds for control of other diseases would be sufficient for this trouble. No control is suggested for transplanted seedlings, except in plantings used as ornamentals, where the greater value of the plants warrants spraying with a copper fungicide.

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THE LOWER VERTEBRATE FAUNA OF THE WATER HYACINTH COMMUNITY IN NORTHERN FLORIDA

Coleman J. Goin
University of Florida

Although the water hyacinth, *Piaropus crassipes* (Mart.) Britton, is extremely abundant and widespread in the southeastern states, very little attention has been given to the fauna that is now associated with its luxuriant growth. Many bodies of water in this region support large masses of the hyacinth, and some are entirely covered by this floating plant. In the lakes and larger sluggish rivers it drifts to and fro with the wind, and it often completely blankets the small ponds, canals, and ditches.

The roots of *Piaropus* develop directly in proportion to the depth of the water. In the shallow water the roots are short, but where the water is deeper they may extend downward to a depth of three feet. These large masses of filamentous roots, shaded as they are by the floating portions of the plants, provide an extensive cover for numerous animals. Moreover, there is a huge and continuous accumulation of hyacinth detritus on the bottom of all hyacinth-supporting bodies of water, and this detritus not only modifies the physical conditions on the bottom but, where the plants are thick, also supplies an enormous mass of organic food. At Newman's Lake, for example, although the greater part of the lake is open water and only the margins are typically covered with hyacinths, a bottom sampling made with an Eckman dredge at nearly any point in the lake will be found to contain many fragments of dead hyacinths.

Professor M. D. Cody, of the University of Florida, informs me that this plant was first brought into the United States in 1835 by the Venezuelan delegates to the Centennial Exposition at New Orleans. Visitors to the Exposition received these plants as souvenirs and, by carrying them home, introduced them to many parts of the Southeast. It was not until about 1840 that the plant became established in Florida. After its first establishment it was carried to different parts of the state by cattlemen who believed the hyacinth was of value as cow feed.

The abundant and luxuriant growth attained by the hyacinths has attracted a great number of aquatic and semiaquatic animals which have become associated with it. Among the invertebrates characteristic of the hyacinth community may be mentioned oligochaete worms

(*Dero*), jawed leeches (Gnathobdellida), amphipods (*Hyalella*), a crawfish (*Procambarus fallax*), water spiders (*Dolomedes*), and midges (*Chironomus*).

In the course of other studies, I have kept records of the fishes, amphibians, and reptiles found in this community. Most of these records are based on about two years' active and intensive collecting, while random notes have accumulated over a period of some six years. In addition, records from the University of Florida Department of Biology collections have been included in cases where the specimens are known to have been collected among water hyacinths. My absence from Florida during the summers has prevented me from collecting during the months of June, July, and August. All of the records given here are for the vicinity of Gainesville, Alachua County, Florida. Representatives of all species have been deposited in the Carnegie Museum or in the Department of Biology, University of Florida, but it did not seem advisable to collect large series of the abundant species. However, records of all of the rarer and less well known species are based upon laboratory-identified material. Undoubtedly some of the species less commonly associated with the hyacinths have been overlooked, but I believe that I have records for all of the conspicuous elements of the lower vertebrate fauna in this region.

In collecting animals from this community, I used a dredge which was built specifically for the purpose, and which has been recently described (Goin, 1942: 183). This dredge can be inserted under a mat of hyacinths, then raised and carried ashore, where the mass of plants is taken apart and the animals removed.

Many friends have at various times assisted me with the collecting, but I wish in particular to thank Mr. J. C. Dickinson for his help on many occasions. I also wish to thank Professor M. D. Cody for information regarding the water hyacinths, and Dr. A. F. Carr for his continued aid and assistance and especially for verifying the identifications of the fishes. Finally I wish to thank Professor J. Speed Rogers for his aid and advice throughout the study and in the preparation of this manuscript.

Except where proposed changes have been published, the names of the fishes in the following list are as given by Carr in his key to the fresh-water fishes of Florida (1937), and the nomenclature of the amphibians and reptiles follows Stejneger and Barbour's recent check list of North American amphibians and reptiles (1943).

FISHES

Lepisosteus platyrhincus De Kay

Florida Gar

This form is common in the hyacinths around the edge of Newman's Lake. I have records for April, May, June, September, October, and Novmber.

Amia calva Linnaeus

Bowfin

The few spring records I have for this species (locally called the mudfish) do not give a true picture of its abundance. I have seen four or five grown individuals on the edge of Payne's Prairie in a single evening. Records for February, April, May, and October.

Signalosa petenensis vanhyningi Weed

Florida Threadfin Shad

While I have never collected this form among hyacinths, Dr. A. F. Carr informs me that in Newman's Lake the eggs, which are laid in open water, frequently come in contact with the roots of the hyacinths and adhere to them.

Erimyzon sucetta sucetta (Lacépède)

Eastern Lake Chub-sucker

Only once have I collected this species among the water hyacinths, but there are records in the Biology Department collection for January, February, March, April, October, and November.

Notemigonus crysoleucas boscii (Valenciennes)

Southeastern Golden Shiner

I have records for January, March, April, October, and November.

Notropis maculatus (Hay)

Spotted Shiner

My only records are for February, April, and October.

Ictalurus catus (Linnaeus)

White Catfish

Although rare in the smaller bodies of water, this catfish is often caught by fishermen in many of the larger lakes and streams. The only locality in which I have found it definitely among the hyacinths is where a small stream enters Newman's Lake. Commercial fishermen quite often take it in the same region. Records for February, March, and October.

Ameiurus nebulosus marmoratus (Holbrook)

Marbled Brown Bullhead

This fish is commonly found among the water hyacinths. Records for February, March, April, May, October, and December.

Ameiurus natalis erebennus Jordan

Southeastern Yellow Bullhead

The yellow bullhead is not so common as the preceding. Records for February, March, and November.

Schilbeodes gyrinus (Mitchill)

Tadpole Madtom

This form is abundant around the roots of the hyacinths. Records for February, March, April, October, and December.

Esox niger LeSueur

Chain Pickerel

The chain pickerel, or jackfish, is seldom abundant in this habitat as an adult, but in the spring of the year the young are sometimes plentiful. During March, 1941, young individuals from 5 to 25 mm. in length were very numerous among the hyacinths on the edge of Newman's Lake.

Chriopeops goodei (Jordan)

Red-finned Killifish

This fish is rarely found among hyacinths. My only records are for the month of February.

Fundulus chrysotus (Günther)

Golden Topminnow

Fundulus is fairly common. Records for January, February, March, April, May, September, October, November, and December.

Jordanella floridae Goode and Bean

Flagfish

This is one of the most abundant fish in muddy, hyacinth-covered water. It can be collected with ease even after the water has been stirred up and is exceedingly murky. Records for January, February, March, April, October, November, and December.

Heterandria formosa (Agassiz)

Least Killifish

This species is very rare among the water hyacinths. I have one record for March.

Gambusia affinis holbrookii (Girard)

Eastern Mosquito-fish

This fish is commonly found, but never in the great numbers in which some of the other small fish occur. Records for January, February, March, April, May, October, November, and December.

Hololepis barratti (Holbrook)

Florida Swamp Darter

I have records of the darter for February, April, October, and November.

Pomoxis nigro-maculatus (LeSueur)

Black Crappie

The black crappie, or speckled perch, is abundant in Newman's Lake but is seldom taken except during the months of February and March, when the fish enter the hyacinth-clogged streams that empty into the lake. At this time as many as thirty or forty may be caught on a hook and line in a single afternoon, when topfish (*Fundulus* and *Gambusia*) are used as bait. During these spring months they may also be caught all around the shore, but never in as great numbers as in the mouths of the small creeks.

Huro salmoides (Lacépède)

LARGEMOUTH BASS

Although I have never collected this bass among the hyacinths with my dredge, it certainly occurs there. Fishermen often catch it among the hyacinths both with hook and line and with artificial bait.

Enneacanthus gloriosus (Holbrook)

BLUE-SPOTTED SUNFISH

I do not believe that my few spring records give a true picture of the abundance of this species. Records for January, February, and March.

Chaenobryttus coronarius (Bartram)

WARMOUTH BASS

This form, locally called chub, is very abundant in the shallow waters near the edges of lakes and streams. A voracious feeder, it can be taken by any moving bait. I have seen as many as eighty individuals caught by one man in a single afternoon while fishing with a hook and line on Payne's Prairie, a large, hyacinth-covered marsh about four miles south of Gainesville. I have records for January, February, March, April, October, November, and December.

Lepomis macrochirus purpurescens Cope

EASTERN BLUEGILL

This locally important panfish is often caught among the hyacinths. Records for January, March, April, October, and November.

Lepomis marginatus (Holbrook)

FLORIDA LONG-EARED SUNFISH

I have records for February and March.

Elassoma evergladei Jordan

EVERGLADES PIGMY SUNFISH

The pigmy sunfish is not common. Records for January and February.

Labidesthes sicculus vanhyningi Bean and Reid

SOUTHEASTERN BROOK SILVERSIDES

In central Florida *Labidesthes* is characteristically found in clear bodies of water. I have two records for its occurence among the hyacinths, once in February and once in March.

AMPHIBIANS

Amphiuma means means Garden

TWO-TOED AMPHIUMA

I have never found this form common in the water hyacinth community. I have records for January, February, March, October, November, and December.

Triturus perstriatus Bishop

Florida Striped Newt

This newt is relatively rare in the Gainesville region. The only time I have taken it definitely in the water hyacinths was on February 18, 1937, when I collected four adult specimens in a small, hyacinth-covered, woods pond about three miles east of Gainesville.

Triturus viridescens louisianensis (Wolterstorff)

Louisiana Newt

The Louisiana newt is abundant in shallow water among the roots of the water hyacinths during the winter months. A gravid female was collected and placed in an aquarium on February 8, 1940. She deposited three eggs on the bottom that night, and five additional eggs on February 12. The first three eggs were stuck together in a string, but the five eggs laid on the twelfth were deposited singly. An adult male collected on the same date regurgitated an adult *Gambusia.* Records for January, February, March, and October.

Manculus quadridigitatus (Holbrook)

Dwarf Salamander

Van Hyning (1933: 3) lists this form as common "among leaves in dried-up ponds in woods, and among roots of the water hyacinths (*Piaropus crassipes*)." It is often found in small woods ponds that are covered with hyacinths, but I have seldom taken it among the hyacinths in large bodies of water. Records for January, February, March, October, and November.

Pseudobranchus striatus axanthus Netting and Goin

Narrow-striped Siren

No other aquatic vertebrate in Florida seems to be so restricted to the water hyacinth habitat as is *P. s. axanthus.* I have collected extensively in Alachua County for this species, and while it is usually abundant in all of the hyacinth-covered lakes, prairies, and ditches that I have worked, I have never had any success seeking for it in other situations. Records for every month of the year except June, July, and August.

Siren lacertina Linnaeus

Great Siren

This species is quite common in and among the roots of the water hyacinths in the Gainesville region. I have seen several dozen in a single evening while wading near the shore in Payne's Prairie. Records for February, March, April, October, and December.

Acris gryllus (Le Conte)

Cricket Frog

Acris gryllus is extremely common at all seasons of the year around the edges of bodies of water covered with *Piaropus.* I once saw a large water spider (*Dolomedes*) catch and kill a full grown cricket frog. Records for January, February, March, April, May, October, November, and December.

Hyla cinerea cinerea (Schneider)

Green Tree Frog

The green tree frog has been found climbing about on the emergent portions of water hyacinths on several occasions. Concerning this species, Kilby

(MS 1936) says, "By far the greatest concentration of individuals is found among lake or pond shore vegetation and on the floating rafts of water hyacinths that are common in Florida Lakes." My own records are for January, February, and October.

Hyla crucifer bartramiana Harper

Southern Spring Peeper

The six specimens from Alachua County, Florida, listed by Harper (1939: 2) in the original description of this form, were taken in a small woods pond which is nearly completely covered with hyacinths. The greatest number of individuals I have seen at any one time in northern Florida was in the above mentioned pond, where I collected eighteen on the evening of December 31, 1940. In the Gainesville region the peepers usually enter the ponds and marshes in late December, and continue to call spasmodically until early spring. My only collection records are for February and December.

Rana catesbeiana Shaw

Bullfrog

In the Gainesville region adults of this species are seldom found in the hyacinth-covered ponds and streams, but immatures are quite common in this habitat in the spring. Records for January, February, March, and December.

Rana clamitans Latreille

Bronze Frog

The bronze frog is very seldom found among the hyacinths. In Florida this form seems to prefer springs and seepage areas in heavily forested areas to any other habitat. My only records of its occurrence with the water hyacinths are for January and December.

Rana pipiens sphenocephala Cope

Southern Leopard-frog

This frog is quite common near the edges of the larger bodies of water. Records for January, February, October, November, and December.

Microhyla carolinensis (Holbrook)

Narrow-mouthed Toad

I have never taken this toad among the hyacinths proper, but it can often be found under mats of dead hyacinths that have been thrown up on shore. Records for April, October, and November.

REPTILES

Alligator mississippiensis (Daudin)

Alligator

Alligators are, unfortunately, becoming quite rare in many parts of the state; but about fifteen or twenty years ago they were regularly seen in Newman's Lake, a large lake that has long supported a dense growth of hyacinths. It was then not at all unusual to be able at a single time to count six or eight large "gators" floating at the surface of the water.

Sternotherus odoratus (Latreille)

STINK-JIM

The few records of this and the following form do not give a true picture of their relative abundance in the water hyacinth community. They occur commonly in many aquatic situations, particularly those that are choked with trash or vegetation. Records for February and October.

Kinosternon baurii baurii Garman

STRIPED MUSK-TURTLE

Records for January, February, October, and December.

Kinosternon subrubrum steindachneri Siebenrock

FLORIDA MUSK-TURTLE

The Florida musk-turtle can often be seen sunning itself in hyacinth-filled road ditches, canals, and ponds. Records for January, March, May, and October.

Pseudemys nelsoni Carr

NELSON'S TERRAPIN

This "cooter" is quite common on Payne's Prairie, a large, hyacinth-covered marsh about four miles south of Gainesville. Records for January, February, April, May, August, October, and December.

Deirochelys reticularia (Latreille)

CHICKEN-TURTLE

Unquestionably this is one of the most ubiquitous of all Florida turtles, occurring in large clear lakes, rivers, marshes, prairies, ponds, and ditches. The only records I have in which it was definitely among the water hyacinths are for March and December.

Farancia abacura abacura (Holbrook)

HORN-SNAKE

The horn-snake is abundant in densely vegetated muddy marshes; it is very common on Payne's Prairie. Records for January, February, March, April, September, October, and December.

Diadophis punctatus punctatus (Linnaeus)

SOUTHERN RING-NECKED SNAKE

I have never collected this snake among the water hyacinths, but Carr (1940: 79) states "I have found several in the water among water-hyacinth roots with *Farancia* and *Pseudobranchus*."

Lampropeltis getulus floridanus Blanchard

FLORIDA KING-SNAKE

The Florida king-snake is wide spread but not particularly abundant. Records for February, March, April, May, September, and October.

Natrix sipedon pictiventris Cope

FLORIDA BANDED WATER-SNAKE

This snake is extremely common and wide spread. Records for March, April, May, October, November, and December.

Seminatrix pygaea (Cope)

RED-BELLIED MUD-SNAKE

With the possible exceptions of *Pseudobranchus s. axanthus* and *Liodytes alleni,* this snake seems to be more closely correlated with water hyacinths than any vertebrate known to me. I have records for February, March, May, October, November, and December.

On the afternoon of October 18, 1939, I collected a large female which that night gave birth to eight young. The following table gives the measurements and scale counts of this series of young. The catalogue numbers are those of the Carnegie Museum.

CM No.	Sex	Scale Rows	Abdominals	Sub-caudals	Total length	Tail length
18753	♂	17-17-15	121	54	129	31
18754	♂	17-17-15	123	54	127	29
18755	♂	17-17-15	126	53	134	30
18756	♀	17-17-15	127	44	123	24
18757	♀	17-17-15	125	45	124	25
18758	♂	17-17-15	126	55	128	30
18759	♀	17-17-15	122	42	124	24
18760	♀	17-17-15	125	45	124	25

The mother (CM18752) had a maximum of 17 scale rows, 122 abdominals, 43 sub-caudals, and a total length of 379 mm. and tail length of 67 mm.

Liodytes alleni (Garman)

ALLEN'S MUD-SNAKE

As stated by Carr (1940: 92), this is probably the most aquatic snake in Florida, and is fairly common among the water hyacinth roots in shallow water. Records for February, October, and December.

Agkistrodon piscivorus piscivorus (Lacépède)

COTTON-MOUTH MOCCASIN

I have never found this snake common among the hyacinths. It seems to me to be more commonly found along the borders of lakes and streams in heavily wooded regions. I have records of its occurrence among the hyacinths for February, April, May, and December.

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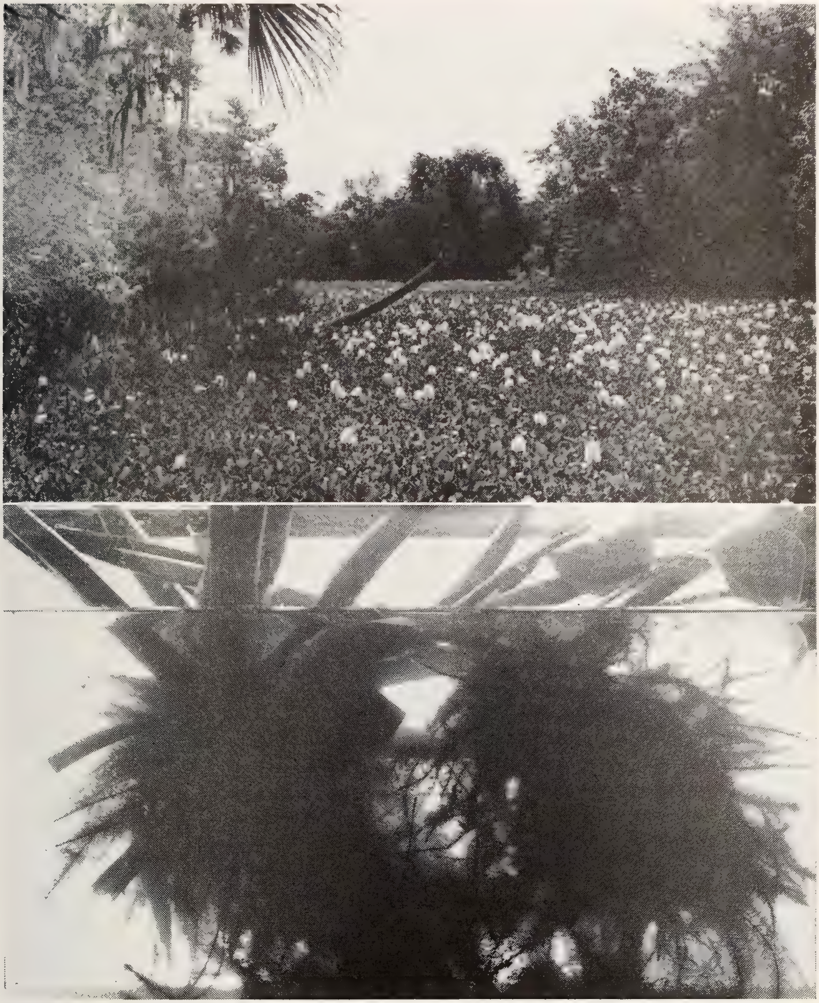

PLATE I

Water hyacinths (*Piaropus crassipes*)

Upper.—A mass of water hyacinths competely covering the mouth of a creek entering the St. Johns River.

Lower.—Two individual plants in an aquarium showing the submerged root system.

—Photographs by Albert M. Laessle.

A CONTRIBUTION TO THE NATURAL HISTORY OF THE FLORIDA SHORT-TAILED SHREW

JOSEPH C. MOORE
Department of Biology, University of Florida

The Florida short-tailed shrew, *Cryptotis floridana* Merriam, is one of the smallest animals native to Florida. It belongs to the order of insectivores and comes of a family famous for diminutive bodies, rapacious appetites, secretive habits, unresting activity, irritable nature and none-too-pleasant odor. Other members of this family, the Soricidae, known to occur in the state are the Carolina short-tailed shrew (*Blarina brevicauda carolinensis*), the Everglade short-tailed shrew (*Blarina brevicauda peninsulae*), and the Bachman shrew (*Sorex longirostris longirostris*).

The Florida short-tailed shrew is a mammal about the size of a lady's little finger, salt-and-pepper gray above and slightly lighter beneath. Its feet appear proportionately small; its rather short tail is not remarkably hairy. It has a long pointed nose, very small eyes, and no external ears. The lack of external ear undoubtedly suggested the generic name *Cryptotis* or "hidden ear."

Before proceeding with the discussion on this animal, I wish to express my gratitude to Professor H. B. Sherman whose help, guidance and encouragement made this paper possible; to Professor J. Speed Rogers who arranged for me to live on the University of Florida Conservation Reserve at Welaka where this study was carried on, and to the many others who helped, encouraged, or simply endured.

The known distribution records of the Florida short-tailed shrew were published by Professor Sherman (1937: 105) in his check list of the land mammals of Florida. More recent records have not appreciably extended the known range.

Recorded information concerning the natural history of this shrew consists almost wholly of casual references to the types of habitat in which the species has been taken. Chapman (1894) tells of finding the remains of one whole individual and the skull of another in the stomach of a barn owl taken in Gainesville. Both Elliot (1901: 55) and Smith (1938: 372) found this animal inhabiting palmetto hammocks in the vicinity of Sanford. Merriam (1895: 19), acquainted with it only through four specimens, laconically gives the habitat as "palmetto scrub." Bangs, who took many specimens and was of the opinion that this shrew occurs in all sorts of situations, wrote (1898: 209): "I have taken it on barren sand hills, in old fields, in hummocks, swamps, piny woods, under brush piles, and at the edge of the salt marsh." He considered its favorite abode to be among the rushes that fringe the borders of small fresh-water ponds, especially near the edge of the salt marsh. Bangs also notes that these shrews like others "have a great fondness for eating each other in the trap; usually they begin with the head." Blair (1935: 274) was the first to publish critical data on the relative numbers of individuals trapped in different types of habitats.

HABITAT PREFERENCES: The results of Blair's trapping of *Cryptotis* and *Blarina* on the Biology Station grounds at Newman's Lake, near Gainesville, appear to be in agreement with my own results obtained on the University of Florida Conservation Reserve at Welaka, Putnam County, Florida. *Cryptotis* appears to have a greater range of habitat tolerance, having been taken in most of the moist, shady situations where *Blarina* was trapped, and also in relatively dry, open places where *Blarina* apparently did not occur. Table No. 1 presents the figures upon which this statement is based.

TABLE No. 1—Habitat Preferences of Cryptotis and Blarina

1. Number of shrews trapped by W. F. Blair near Gainesville, Florida.[1]

	Dry Pineland	Briar Patch	Grassy Swamp Border
Cryptotis	4	3	3
Blarina	0	2	4

2. Number of shrews trapped by J. C. Moore and J. J. Friauf at Welaka, Florida.

	Flatwoods	Pond Border	Bayhead
Cryptotis	5	1	0
Blarina	0	1	3

[1] Data from Blair, *op. cit.*, p. 274.

SYNONYMY: Characters distinguishing the Florida short-tailed shrew, *Cryptotis floridana,* from its nearest relative to the north, *Cryptotis parva,* were first noted by Professor Baird in 1857; he nevertheless did not describe the Florida form, but referred it to *Blarina cinerea* (a synonym of *Cryptotis parva*). In 1894 Chapman listed it under two different names, both synonyms of *C. parva.* The following year Merriam revised the genus *Blarina,* including *Cryptotis* as a subgenus; he described the Florida form as *Blarina floridana,* and indicated its differences from the related *parva.* *Cryptotis* was given generic status by Miller in his 1912 check list. Harper in 1927 placed *floridana* as a race of *parva,* but it was given specific rank by Blair (1935) and Sherman (1936). This nomenclatorial history is covered by the following list of citations:

Cryptotis floridana (Merriam)

1857. *Blarina cinerea* Baird, *Mammals of North America.*
1894. *Blarina cinerea* and *Blarina exilipes* Chapman, *op. cit.*
1895. *Blarina* (*Cryptotis*) *floridana* Merriam, *op. cit.*, p. 19.
1901. *Blarina floridana* Elliott, *op. cit.*, p. 55.
1912. *Cryptotis floridana* Miller, *op. cit.*, p. 25.
1927. *Cryptotis parva floridana* Harper, *op. cit.*, p. 270.
1935. *Cryptotis floridana* Blair, *op. cit.*, p. 274.
1937. *Cryptotis floridana* Sherman, *op. cit.*, p. 105.

METHODS OF CAPTURE, AND RECORDS: On the University of Florida Conservation Reserve, 3,708 trap-nights with live traps caught only three specimens of *Cryptotis*. Mr. James J. Friauf, a fellow-student who was working on the ecology of the Orthoptera of the Reserve, took two *Cryptotis* in from 300 to 500 trap-nights with "molasses traps" set for crickets and cockroaches. This suggests that some kind of an open pit trap, properly baited, may be effectively used for capturing this tiny animal. Dr. T. H. Hubbell informs me that he has had similar success in capturing shrews with molasses traps in Michigan, Tennessee and other regions; it is a question whether the shrews simply blunder into the pits, or are attracted thereto by the entrapped insects. One *Cryptotis* was found dead and in good condition beside the hard road which runs through the Reserve.

In the following table "No." refers to the catalog number of the specimen in the writer's collection, "Date" to the date of capture, "Skin" to stuffed skins preserved, "Skl." to body skeletons preserved, "Alc." to whole specimens preserved in alcohol. Measurements are recorded in this order: total length, tail-length, length of hind foot, and weight. All linear measurements are in millimeters, and weight is given in grams.

RECORD OF SPECIMENS OF CRYPTOTIS TAKEN ON THE RESERVE

No.	Date	Skin	Skl.	Alc.	Sex	Measurements
M-32	12-13-39			x	F	not taken
M-40	2-25-40	x	x		M	79x23x11x5.0
M-48	3-15-40			x	F	not taken
M-50	3-31-40	x	x		F	74x24x11x5.0
M-58	5-1-40		x		?	78x22x11x3.6
M-107	10-11-40			x	F	not taken

The following notes are made from observations of one individual, a female, which was kept in captivity for more than three months, Oct. 11, 1940 to Jan. 28, 1941. The name "Shivernose" was given to this animal by a small boy, who thought it was cold because, as he said, "It shivered its nose all the time."

NESTS: The shrew was kept in a glass vivarium with the floor covered with sand. It was moved to a clean vivarium every ten or eleven days, and each time this happened it was obliged to make a new den or nest of whatever material was made available. Scrub oak leaves scooped off the ground in the scrubby flatwoods where the shrew had been trapped provided cover in which it hid itself but made no real nest. During cold weather it was given tufts of absorbent cotton which it readily made into a nest. These cotton nests were never so neat and globular as those made under similar circumstances by harvest mice (*Reithrodontomys humulis*), cotton mice (*Peromyscus g. gossypinus*), and golden mice (*Peromyscus nuttalli aureolus*).

On various occasions Shivernose made nests of sphagnum moss or dried grass. At one time the shrew had only the shelter of a flimsy camouflage of bits of dry crab grass which it had dragged together in one corner of its cage. It added to this skimpy cover whenever more material was made available, but abandoned it when a more suitable den was offered in the form of an egg shell. This dried shell of an ordinary hen's egg, into the side of which a hole 18 mm. in diameter had been broken to remove the contents, was actually large enough to have held four shrews the size of Shivernose. It had hardly been placed in the vivarium when the shrew entered it and adopted it as a rather permanent den. A bit of cotton was placed in it for nesting material, but the shrew dragged in more and also pieces of dry grass until there was barely enough room for the shrew.

Smith (1938: 372-373) describes a nest of this species found under a log in the vicinity of Sanford:

> "The nest was loosely constructed of leaves of panic grass (*Panicum mutabile*) and was about 5 inches in diameter. There was no evident attempt at weaving or any other means of fastening the leaves in place; they were loosely piled in a globular mass. Small pieces of shed snake skin, seemingly from a Florida king snake (*Lampropeltis getulus floridanus*), were mixed with the leaves, and were also scattered about the sides of the log away from the nest."

BURROWS AND TUNNELS: Every time that the dried-out sand in Shivernose's vivarium was replaced with fresh, moist sand, the shrew responded by riddling it with tunnels during the night. On two occasions fresh sphagnum moss was spread over the floor of the cage. The sphagnum screened Shivernose's activities too well, however, and in consequence the moss was removed each time after several days. It was noted that whenever the shrew burrowed in the moist sand or sphagnum after having been denied the privilege for several days, its fur become fluffy and more healthy-looking.

On one occasion two ridges about five inches high were moulded by hand in the moist sand, so as to divide the vivarium into three parts. Placed in one of the compartments formed by these ridges, the shrew ran about until it found places where it could climb over the sand walls, and for some time scrambled back and forth from one compartment to another. Presently, I poked a hole with my finger through one wall at the bottom. When the shrew had used this hole for a tunnel several times, it proceeded to dig a tunnel through the other wall. The diameter of the tunnel that it dug was 13 mm. vertically and 18 mm. horizontally.

One time when the sand of the vivarium had become too dry and loose for burrowing, and Shivernose had become accustomed to denning in a particular corner of the arena, which was only thinly protected by a few stems of dried grass, dampening the sand stimulated the shrew to spend much of the night digging tunnels and burrows; although it still spent the days in its grass-covered lair instead of underground. Here the apparently conditioned habit of denning in the corner above ground appeared temporarily stronger than the more common habit of denning in a burrow.

On one occasion when the shrew was placed in a vivarium with fresh sand, water was poured on the sand at one end of the cage with the intention of making it more suitable for burrowing. This must

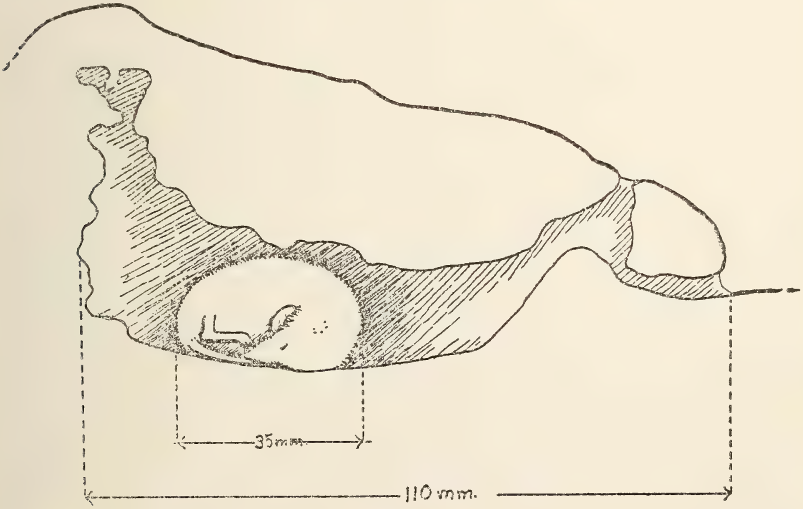

Fig. 1.—"Shivernose" (*Cryptotis floridana*) asleep in its burrow. The shrew's forehead is practically flat on the ground in this sleeping position, and it is lying more on its belly and the top of its head than on its side.

have made the sand too wet, however, for after the shrew had been left in this for a while, it was found asleep in a burrow in the relatively dry end. The whole burrow was against the glass end of the vivarium, so that one saw it practically in longitudinal section. The mouth of the tunnel was nearly closed, through accident or design, and the shrew apparently felt unusually safe, for this was the only time that it was found curled up as shown in figure 1.

SANITATION: At first Shivernose defecated only in one corner of the vivarium, but after a while any corner except that of the den was used. Faeces and urine were extruded simultaneously, the faeces usually in one lump. It took but an instant and was accomplished with a contortion which looked like peristalsis of the whole body. In the latter days of imprisonment, the shrew began the practice of defecating against the glass of its cage, and the faeces stuck to it about 4 to 8 mm. above the surface upon which the shrew stood. This behavior has some similarity to that reported by Carl O. Mohr (1940: 93) of a house mouse (*Mus musculus* Linn.) which, when kept in a tall glass cylinder, took its faeces and stuck them up on the walls of its cage as high as it could. Mohr's remark that "this behavior seemed to be an act of sanitation" might well apply in the case of the shrew, whose behavior at least eliminated the hazard of walking in its own excrement.

The frequency with which such a voracious creature defecates may be of some interest. Once when Shivernose had been in a clean cage nine hours, evidence indicated that it had defecated four times in that period. On another occasion the shrew was observed to defecate twice within 23 minutes.

MOULTING: A line of molt was noticed around the shrew's thorax December 14 to 19.

SENSES: It seemed apparent at times that Shivernose had little use of its eyes. On many occasions it ran within two inches of a large insect without becoming aware of it. Observing the insectivore hunt its food in the vivarium, occasions the belief that it depends a great deal on its ears and even more on its nose in locating its prey. Shivernose often appeared to detect an insect's presence by smell and, while approaching it, its exact location as well. But the shrew appeared seldom able to determine the exact location of an insect further away than an inch or two. By hearing a large insect walk, the shrew apparently could locate it accurately at a distance of three inches or more, and would close upon it from that distance with confidence. On one occision a cornered cricket, which Shivernose approached cautiously, attempted to rush past about three-quarters of an inch from the shrew's head. Instantly aware of this the shrew flirted its head to the side and caught the cricket in full career. The movement was almost incredibly swift.

ALERTNESS: Shivernose was never observed to be relaxed and still. Regardless of where it was, the shrew raised its head and "shivered its nose" to test the air, turned its head this way and that, and whirled about quickly as if to make sure it was not about to be attacked from the rear. However, these moves were made so swiftly and punctually that they gave an impression more of wariness than of timorousness. When the situation was such that the shrew was obliged to eat in the open, it ran from its food every now and then to a corner and crouched there sniffing the air for a few moments. Then it returned to eat some more for a few seconds before repeating this performance. Another caution behaviorism observed was the tendency, when suspicious or alarmed, to run along very close to the walls of the vivarium.

Even on an occasion when the shrew was observed while sleeping in a burrow, it appeared to be sleeping "on the alert." Every now and then it jerked up its head, sniffed the air this way and that, and then curled up again; and sometimes it did an about-face. Also, strange, periodical fits of trembling seized Shivernose as if the little beast were having "bad dreams."

HUNTING: The hunting tactics displayed by Shivernose in attacking a grasshopper in its vivarium consisted of creeping up to within an inch or so of it, and reaching out and snatching it back with its teeth. Then, if the shrew were under the cover of its nest or a tunnel in the sphagnum, it usually only turned about with its prey and proceeded to kill it by biting it in the head. If, on the other hand, it were out in the open, it rushed its victim back to a burrow to kill it there. And, when no shelter at all was at hand, it carried its prey habitually to a certain corner or part of the arena each time.

The shrew's method of attack on crickets differed sharply from that used on grasshoppers. When a cricket was definitely located, instead of creeping up and snatching it, Shivernose charged and closed upon it like a football player upon a fumbled ball. If the cricket fled an instant before the shrew rushed, an exciting but short race ensued. The only place for the shrew to get a good hold on a cricket appeared to be the head, and sometimes it chased big crickets several lengths of the vivarium before getting the right hold. And when it did capture such a one, the shrew snatched it up and scurried back with it holding it high and seemingly bursting with excitement and pride, the hair on the back of its neck standing up high.

The only animal besides the cricket with which the shrew was observed to throw itself into bodily contact while fighting it was a praying mantis. The shrew's fighting in this case was all done in a brief whirl of wrestling and biting from which it emerged chewing the vanquished mantis's head. In all other cases its fighting consisted of dashing in to nip and jumping back.

Once a small (12.3-gram) soft-shelled turtle, *Amyda ferox,* was put into the vivarium with the shrew. Shivernose attacked it at once, nipping it sharply and jumping back again and again. Sometimes the shrew stood on its hind feet shooting out a nip or recoiling after one like a light-weight boxer. After every few such nips, Shivernose ran off to a far corner, tested the air carefully for a few moments, and presently returned to the fray. The turtle made a spirited attempt to escape through the glass but did not offer to do battle. It was taken out before it suffered any real damage.

FEEDING HABITS: When eating from a large insect or chunk of meat, the shrew crouched over the food, holding it down with its forefeet and pulling and tearing at it with its teeth in the manner of a small lion. The food given to the captive shrew most of the time was grasshoppers. These were usually *Melanoplus femur-rubrum propinquus*, *Chortophaga australior,* and another common species about 20 mm. long. Smaller and softer individuals were eaten entirely, as were crickets and other soft-bodied arthropods. With larger grasshoppers the procedure was generally as follows. The shrew began by either eating the grasshopper's head or by biting it loose from the thorax and licking and scraping out the contents of the head through the neck hole. Then, turning to the thorax, the *Cryptotis* tried to clean it out through the neck hole. Having gleaned as much as possible that way, it bit and tore the abdomen loose from the thorax and cleaned out the remainder of the thorax from the posterior end. Next, it ate the femora of the jumping legs in the manner of a boy with a lolly-pop, chewing the fleshy part in one side of its mouth while the distal end protruded as would the lolly-pop handle. Finally, the shrew laboriously ingested the abdomen—starting at one end and chewing until the whole was devoured. This last part was sometimes modified to ripping the abdomen open and stripping it clean, and sometimes was omitted altogether.

On a big, heavily armored beetle, *Passalus cornutus,* the shrew's attack was completely ineffective. When the elytra and pronotum were removed, however, Shivernose readily ate the beetle.

Several times top minnows, (*Fundulus* sp.), varying in length between 20 mm. and 40 mm., were placed in a watch glass which held a disc of water 9 mm. deep and 50 mm. in diameter. In attempting to capture them the shrew stood with both front feet in the water and moved its head alertly this way and that trying to locate a fish. Finding one, the shrew would snap it up and rush down into the underground runways. Sometimes the insectivore put its nose and mouth under water and searched about, apparently trying to locate a minnow by touch. It frequently had considerable difficulty in catching the minnows, for they were very active and apparently difficult for the shrew to perceive even in so shallow a disc of water. To eat a minnow it always started at the head end.

For 48 hours at a stretch Shivernose was sometimes fed nothing but milk. It once lived on cheese longer than that, and also, on another occasion, on corned beef. After taking a bite or two of peanut butter, the shrew often "scooted" its chin along in the sand in an amusing manner and drank water every few seconds for a while. After eating some of the fresh, sticky turtle's egg, the shrew wiped the viscid stuff off its lips with its hands, and then was obliged to rake its hands clean on its teeth. This awkward procedure was very amusing to watch.

FOOD PREFERENCES: During Shivernose's first two months in captivity the plentiful grasshoppers, as previously stated, provided most of its meals, but when cold weather brought a scarcity of grasshoppers, the shrew was offered a rather heterogeneous assortment of other foods, as listed in Table No. 2.

TABLE No. 2—FOOD PREFERENCES OF CRYPTOTIS FLORIDANA

Eaten ravenously:
- Crickets
- Butterfly
- Frogs

Eaten readily:
- Grasshoppers
- Termites
- Beetles (*Passalus cornutus*)
- Minnows (*Fundulus* sp.)
- Hamburger
- Ovarian turtle's egg
- Beef tenderloin
- Soft-shelled turtle flesh
- Pocket-gopher flesh
- Cotton rat flesh
- Flying squirrel flesh

Eaten unenthusiastically:
- Sardines in brine
- Raw fresh pork
- Raw smoked ham
- Roast pork
- Corned beef
- Milk
- Cream
- Hen's egg
- Cheese
- Peanut butter

Eaten with reluctance:
- Fresh bream and bass heads
- Opossum flesh
- Beetle larvae (*Passalus cornutus*)
- Walking stick
- Rabbit liver

Refused:
- Scorpion
- Mantis
- Smoke-cured breakfast bacon

The captive *Cryptotis* showed a definite preference for crickets over grasshoppers. When several of both were dropped into its cage, the shrew ran about among them biting the grasshoppers in the head to kill or cripple them. But usually when it caught a cricket the insectivore stopped to eat it. If a crippled grasshopper stirred more than suited the shrew, it stopped eating the cricket to bite the grasshopper savagely in the head, and then returned to finish eating the cricket. Only after the crickets were all gone did the shrew start eating grasshoppers.

Shivernose apparently fasted twenty-four hours rather than eat smoke-cured breakfast bacon. That is an exceedingly long fast for a shrew. In regard to cheese, which several times supported Shivernose for as long as 48 hours, it should be pointed out that with cheese present in its cage, another shrew of this species died on the second day of captivity, apparently of starvation.

HOARDING FOOD: Shivernose dug a burrow at one end of the vivarium so that the chamber was against the glass. I could see the shrew in this chamber when I began dropping grasshoppers and crickets into its glass cage two or three at a time. The first several were crickets. Shivernose came forth and captured and ate the first three in three minutes, and carried the fourth down into the den. After remaining below with it for a minute or so, the shrew emerged and began to carry insect after insect down, until I suspected it of not eating them and peered into the den through its accidental glass window. Sure enough, the grasshoppers and crickets were piled three deep. Each time Shivernose brought an insect in, shoved it over the top of the others, bit its head vigorously, and dropped it. Then, for a minute or so the shrew crouched there, darting an additional nip at the head of whichever victim moved unduly. Presently it went to one of the two openings to the surface and, after testing the air with its nose, emerged and darted swiftly about the arena until it located a victim. Seizing it, the shrew sped back across the surface and down into its burrow as fast as the eye could follow. Sometimes it carried a big grasshopper in such a way that the narrow entrance of the burrow knocked the insect from the shrew's jaws. This never slowed up the shrew's entrance. It turned about down below, reached up again, and jerked the grasshopper down. In thirty minutes Shivernose had eaten four or five (at the most) and hidden away twenty grasshoppers and crickets in this way.

When the rain of grasshoppers had ceased and the shrew had taken a last scout around, it rested crouching in its crowded store-house for about three minutes. Then it began to dig into the sand wall of one side of the chamber, kicking the sand over the recumbent grasshoppers. In two minutes it had dug a new chamber and completely covered up its cache. The shrew undoubtedly used some of this store of food during the 12-14 hours before it was fed again.

DRINKING: During the hunting of the last five or six grasshoppers of the hoarding episode, the shrew stopped to drink water four or five times. It always drank copiously after eating peanut butter or brine sardines. Its method of drinking, quite different from that of its relative, the mole, was to take a sip and raise its head to let the water run down its throat, the way a chicken does. This was done so quickly that the shrew must have taken two or even three sips a second. Although it seldom drank more than three or four sips at a time, it was once observed to drink eleven sips within a minute or so, when it had been without water for some hours.

BREATHING: Shivernose's breathing rate at rest is about 170 times per minute. This figure was arrived at by averaging eight counts made when the shrew was napping. The room temperature was between 70 and 80° F. During the waves of trembling which passed over its body every fifteen or twenty seconds, the shrew's breathing became extremely rapid for a moment. This made exact counting very difficult.

VOICE: The captive shrew often emitted tiny, bird-like chirpings. Just what occasioned them is hard to say. When it was in its nest under the sphagnum, I tried for a while to teach it to come up for food when called in a certain way. This experiment was not successful; but when I called for it to come out and tapped on the sphagnum above its nest, it nearly always responded with that feeble, cheerful chirping. Later on, when Shivernose was sitting undisturbed in the egg-shell nest, we often heard the small beast twittering in that high-pitched, tiny voice.

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HEALTH AND NUTRITION STUDIES IN FLORIDA

L. L. RUSOFF
University of Florida

"America is the best fed nation in the world today." Yet some 40 or 45 million people in the United States are improperly nourished and are not getting enough food or the right kind of food for health and strength, according to dietary studies released by governmental agencies. Many of these people do not show such symptoms of malnutrition that they must go to bed, but the effects of the "hidden hunger" from the lack of the most important nutrients of the diet—vitamins and minerals—are there just the same, and result in a lowered efficiency. People do not need to be starving to be improperly nourished.

In the studies referred to, malnutrition was found to be more prevalent in the southeast than in the north and west; more prevalent among families of the low income classes than in the high and among the negro as compared to the white. Out of a million young men given physical examination by the army, "a total of 380,000 have been found to be unfit for general military service under present standards." It is estimated that "perhaps one-third of the rejections were due either directly or indirectly to nutritional deficiencies."

How do the health and the nutrition of the people of Florida compare with those of the nation as a whole?

The State Board of Health received a communication[1] from Doctor R. A. Vonderlehr, Assistant Surgeon General, Division of Venereal Disease Control, U. S. Public Health Service, stating that "Florida has the highest syphilis rate of any state in the nation." The data were obtained from physical examinations of 19,000 selectees and volunteers in Florida. From the examinations and positive blood tests, it was estimated that 53.5 per 1000 whites were afflicted with syphilis, 380.4 per 1000 negroes, and 66.0 per 1000 of the general population of the state.

For the year 1940, the U. S. Bureau of Census ranked Florida, together with South Carolina, highest in maternal mortality rate in

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[1] *Florida Health Notes,* vol. 33, July 1941.

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the nation; fourth highest of the 48 states in malaria and automobile accidents; seventh in pellagra; ninth in infant mortality; twelfth in both tuberculosis and typhoid; fifteenth in diarrhea and enteritis; and twenty-first in pneumonia.

How well fed is Florida? Dr. Ouida D. Abbott and her associates[2] of the Home Economics Department, Florida Agricultural Experiment Station, have for twelve years collected specific data on dietary deficiencies occurring among the people of Florida. Among ten thousand subjects, three-fourths of whom were rural school children, approximately one-third had some degree of vitamin A deficiency, about three-fourths had decayed teeth, and about one-half had gingivitis (inflamation of the gums).

Iron is one of the most important of the mineral elements of the human body. It is necessary for the formation of haemoglobin of the blood, and an insufficient amount of iron in the diet results in anaemia. Of 4,335 rural children, 53% were definitely anaemic, 23% had borderline anaemia, and only 23% were normal. More than 10% had haemoglobin values between 50% and 21%. Of 100 rural white pregnant women, 80% were anaemic.

The most prevalent nutritional defects were nutritional anaemia and conjunctivitis, pellegra, underweight and overweight, dental caries, gingivitis, and general malnutrition brought on by multiple dietary deficiencies.

When all types of families were considered— high, medium, and low income classes, including negro, foreign born, and broken families in Florida— it was estimated that only 4 to 6% had good diets, about 25% had fair diets, while 60 to 70% had diets rated as poor. It is well known that milk, butter, eggs, fruits, vegetables and meats will supply the needed vitamins and minerals. In this study it was found that milk was used in only 28% of the diets, butter and eggs in 30%, leafy vegetables in 27%, and fruit in only 29%. Rice, grits, corn meal, white bacon, syrup and biscuits were found to be the foods most often used.

The major causes of malnutrition indicated were misfeeding and underfeeding, inadequate production and distribution of food, low incomes, ignorance, and poor food habits. Many families lack the ability and information to choose a good diet.

What are we going to do about this serious stituation? How can these people obtain the right foods? How can they obtain the money to buy enough? How can we get them to buy wisely? Education of the general public in the basic principles of nutrition is necessary. Food habits are established firmly and are changed with great difficulty. Therefore, the basic principles of nutrition must be taught in the grade schools and continued in the schools of higher learning. Why is it not just as important to teach children about our common foods and what they do for us, as it is to teach them to calculate interest on 250 dollars invested at 3%? The school lunch in every school, consisting of a balanced, adequate meal, is one of the ways these nutritional deficiencies are being corrected. Adequate lunches sometimes turn an apparently stupid child into a normal one.

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[2] O. D. Abbott, "Nutritional Anemia in Florida." Presented before the Milbank Memorial Conference, New York, April 1, 1940.

The most prevalent deficiencies in this country today are those of the vitamin B complex—thiamin (Vitamin B_1), riboflavin (vitamin G), and nicotinic acid (the anti-pellegra factor)—and of iron.

Bread and cereals usually furnish about one fourth of the calories in an average diet, and for this reason governmental agencies have supported the plan of the milling and baking industry to "enrich" soft white flour with the essential vitamins of the B family, and with minerals. The enriched flour contains 1.66 milligrams of thiamin, 6.15 milligrams of nicotinic acid, and 6.15 milligrams of iron per pound (one milligram is equivalent to 1/28,000 of an ounce). Although these amounts are infinitesimal, they are almost sufficient to take care of the body's needs for these essential substances when a person eats at least 6 slices of "enriched" bread daily, or 6½ ounces of flour. The benefits derived from eating "enriched" bread should be brought home to the public for no other reason than to assure Mrs. "Average Consumer" that enriched flour and bread are for *her* benefit, and not to help the industry.

Besides all the federal, state and professional agencies directly concerned with nutrition, I believe that various lay groups within the state—the schools and colleges, women's clubs, parent-teacher associations, religious, fraternal and civic societies—are or should be vitally interested in nutrition and public health. These groups can do a real service, through forums, discussion groups, and the intelligent use of the press and radio, in teaching the people of their community the fundamental principles of nutrition, and explaining why so many are suffering from vitamin starvation when we have food in abundance.

Miss Harriet Elliot, chairman of the Advisory Commission in National Defense, has said, "Battle ships, tanks, and planes—they are our first line of defense. But the sword is no stronger than the arm which wields it, nor the plane more useful than the hand and eye which guides it.... Undernourished people are a liability.... Let's make America strong by making Americans stronger."

REPORT ON PROJECTED ARCHIVES DIVISION OF THE STATE LIBRARY

DOROTHY DODD
Florida State Library

Although the territory that now comprises the State of Florida has the longest recorded history of any region in the continental United States, it is doubtful if there has been in any other state so great a destruction and dissipation of public archives.[1] The unsatisfactory condition of Florida's archives and the desirability of making proper provision for their care have long been recognized, but the Legislature has not yet seen fit to adopt effective measures for their preservation.*

As early as 1870, the Secretary of State (the officer to whom is entrusted the custody of "the records of official acts of the Legislature and Executive Departments of the Government"),[2] reported, when requesting the appointment of a librarian to classify and index his records,

> Constant applications are made for papers relating to matters of the highest importance to the public welfare, and yet such was the confusion in which the records and files of the office were found, that it would require the entire time of one person to search for papers either mislaid or entirely lost.[3]

Another state official, in 1891, referred to

> the conglomerate mass of printed and manuscript matter piled in two rooms of the Capitol, and by courtesy called the library, which is surely, and not very slowly, going to destruction.[4]

In 1906, David Y. Thomas, reporting for the Public Archives Commission on Florida's archives, spoke of "the disorder and confusion that has resulted from years of neglect."[5] Thomas began his investigation of the records of the Secretary of State in the coal bin of the capitol, and proceeded thence to the garret, where he found the floor covered with papers. When Thomas procured the removal of certain volumes relating to early state censuses to the office where current census records were kept, the officer in charge refused to allow them to be brought in, "on the ground that he had no room for them and that they were worthless." Thomas concluded that, "The confusion is likely to continue until the legislature provides room and employs an archivist to classify and index the records."[6]

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[1] Fortunately for the historian, large bodies of material bearing on Florida history, especially that of the colonial and territorial periods, are to be found in archival repositories elsewhere in the United States and in Europe. Their distribution has been discussed by James A. Robertson in "The Archival Distribution of Florida Manuscripts," *Florida Historical Quarterly*, vol. 10 (1931), pp. 35-50.

*Since 1941, when this paper was written, the Legislature has authorized the transfer to the State Library Board of the non-current records of any official department or agency of the state.

[2] *Constitution of the State of Florida* (R. A. Gray, Secretary of State, 1940), Art. IV, sec. 21.

[3] "Report of Secretary of State," Florida House of Representatives, *Journal*, 1870, Appendix, pp. 20-21.

[4] "Report of the Adjutant-General for the Period Ending December 31, 1890," Florida House of Representatives, *Journal*, 1891, p. 35.

This plea of lack of room is one of the principal causes of the destruction of Florida's records. At some time in the present century, probably since Thomas' report, for lack of more appropriate housing facilities two dry wells on the capitol grounds were made archival repositories. The writer, some eight or ten years ago, saw a mass of old papers piled at one of the basement entrances of the capitol, awaiting the trash man. They proved to be unbound records of the Comptroller's office for the years between 1840 and 1870. When the colored janitor was asked if any more records were to be discarded, he replied, "I don't know, Miss; I hasn't rightly decided yet."

Such unorthodox "reduction" of records seems to have ceased of recent years, and present state officers evidence a desire not only to care properly for records of current administrative importance, but to preserve and restore to order the older archives. The limitation of space still persists, however, and until adequate facilities are provided for the housing of noncurrent records, the loss and destruction of such records is bound to continue.

The other chief cause of archival destruction is the lack of centralized responsibility for the care and administration of public records. The president of the Society of American Archivists, writing in 1939, pointed out that Florida is one of fifteen states "which still rely upon the generally ineffective system of departmental custody and have not established state archival agencies."[7]

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[5] "Report on the Public Archives of Florida," *Annual Report of the American Historical Association,* 1906 (Washington: Government Printing Office, 1908), vol. 2, p. 151.

[6] *Ibid.*

[7] Albert Ray Newsome, "Uniform State Archival Legislation," *The American Archivist,* vol. 2 (1939), p. 6.

[8] *The Compiled General Laws of Florida,* 1927 (1 vol. ed.; Atlanta: The Harrison Co., 1928), secs. 5054-5058.

Only by courtesy can Florida's laws relating to public records be termed a "system." They can be summarized in short order. Provision was first made for the re-establishment of lost papers in 1829, and has since been extended to cover the records of any public office.[8] Since 1832, penalties have been provided for the failure of any officer to turn over to his successor the official records of his office, and for the theft, fraudulent alteration, or defacement of public records.[9] Since 1909, all state, county, and municipal records have been required to be open at all times for personal inspection by any citizen of the state,[10] and since 1915 the right of photographic reproduction of public records has been granted to persons having the right to inspect them.[11]

In addition to enacting these provisions applicable to all public records the Legislature has, from time to time, taken cognizance of the need to preserve certain specialized groups of records. When the state government was organized in 1845, "the custody, keeping and care" of all records and documents originating in the offices of the Governor and Secretary of the Territory of Florida and in the Legislative Council of the Territory were entrusted to the Secretary of State.[12] Thomas' report of territorial records showed that they were far from complete,[13] and a survey made several years ago by the Florida Historical Records Survey, the results of which have not been published, indicates that important records series noted by Thomas are not now to be found.

The abolition of the federal offices of Keepers of the Public Archives in 1848 caused the Legislature to provide for the appointment of state officers of the same title, who were to receive and administer the Spanish Archives in Pensacola and St. Augustine.[14] Since the federal government decided to transfer the archives to the United States Surveyor General instead of to the state,[15] the law seems to have been inoperative. Shortly before the abolition of the office of Surveyor General in Florida in 1906, all the Spanish records that did not relate to land claims were sent to the Library of Congress.[16] When the Surveyor General's office was abolished, the government proposed to transfer the remaining Spanish archives, as well as the records of the office, to the Secretary of State, but he refused to accept them because of lack of space.[17] The Legislature, therefore, authorized the Commissioner of Agriculture to accept them and directed the Board of State Institutions to provide a suitable place in which to keep them.[18] These records, well cared for and housed in steel vaults, constitute one of the most continuous and important groups of archives in the capitol.

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[9] *Ibid.*, secs. 7492, 7495.

[10] *Ibid.*, sec. 490.

[11] *Ibid.*, sec. 492.

[12] *Ibid.*, sec. 111.

[13] *Op. cit.*, pp. 150-157.

[14] Florida General Assembly, *Acts and Resolutions*, 1848-49, Ch. 28.

[15] Florida Historical Records Survey, *Spanish Land Grants in Florida*, vol. 1, p. ix. (Mimeographed.)

In 1921, the Adjutant General was made custodian of all the state's military records, and was directed "to establish and maintain as part of his office a bureau of records of the services of Florida troops" in the several wars in which they participated. The records were to "be catalogued and arranged or filed for general reference and protection."[19] This is the nearest approach to archival legislation to be found in the Florida statutes.

The 1925 act establishing the present Florida State Library placed in the custody of that agency "all books, pictures, documents, publications, and manuscripts received through gifts, purchase, or exchange, or on deposit for the use of the State."[20] Although no specific reference to archives is made in the act, the Hon. W. T. Cash, Secretary to the State Library Board since its organization in 1927, has been keenly conscious of the importance of saving the state's archives and has literally rescued from the trash pile many records of historical value. He has also constantly and consistently advocated archival legislation. Upon his recommendation, the State Library Board included the position of archivist in its budget for the 1941-43 biennium and, the budget having met with legislative approval, the writer was appointed to the position in August, 1941.

The archival program of the State Library must, perforce, for the time being, be devoted to acquiring and making accessible to students the older records of the state, insofar as they are extant. In spite of the toll taken by the carelessness and wanton destruction which have gone on for years, there is still to be found, in storerooms and valuts in and outside the capitol building, a considerable quantity of archives of importance to historians and other social scientists. It is hoped that the officers now having custody of them will see fit

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[16] Thomas, *op. cit.*, p. 149.

[17] *Ibid.*, p. 158.

[18] *The Compiled General Laws of Florida,* 1927, sec. 204.

[19] *Ibid.*, sec. 2022.

[20] *Ibid.*, sec. 1690.

to deposit them in the Library, where they can be catalogued and made available for research.

Although it is obvious, from what has been said of the destruction of records, that Florida's archives can never be complete, photographic reproduction offers a means of supplementing some extant records and of replacing others in a manner at least satisfactory for research purposes. For example, while it is hardly to be expected that the Spanish archives will ever be returned to the State from the Library of Congress, it is possible to secure for our archives microfilm copies of the more important papers. Similarly, there are in The National Archives in Washington records relating to territorial affairs, photographic copies of which would go far toward restoring the continuity of territorial archives now extant in the state.[21] With this in mind, the State Library Board has recently purchased a Recordak camera and two Argus reading machines. A carefully planned microfilm program should partially remove the sting from the remark of an eminent Florida historian that, "One goes to Florida last for manuscripts concerning its history."[22]

It is to be hoped that the state will soon make possible the expansion of the Library's present modest archival program. Modern government grinds out records as relentlessly as the mythical mill produced the salt of the sea, and the public records of today are the archives of tomorrow. We can never recover what we have lost, but we can take steps to keep what we have and are constantly producing.

As has already been indicated, two steps—and they are big ones—are needed. Proper housing facilities should be provided, and the responsibility for archival administration should be centralized. The ideal solution of the housing problem is the erection of an archives building, which would enable an archives agency to function, as it should, as an administrative agency of the state government. Although only a guess, it is probably no exaggeration to say that a single major department, such as the office of the Comptroller, now creates more records in one month than were produced in a year by the entire state government of seventy-five years ago.

The centralization of responsibility for archival administration can best be secured by the passage of a public records law. Such a law should establish an archival agency, since Florida does not have one in the legal sense of the word. It also

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[21] Even the long-awaited Florida volume of *The Territorial Papers of the United States*, now in process of publication by the State Department under the editorship of Clarence E. Carter, will not, when it appears, obviate the desirability of securing photographic copies of territorial records in Washington, as the Carter compilation is selective, rather than all-inclusive.

[22] Robertson, *op. cit.*, p. 48.

> should provide especially that: (a) official records must be preserved, except where their destruction has been duly authorized; (b) useless records may be destroyed according to certain procedure; (c) noncurrent records may be transferred to the archival agency with the consent of the custodian; and (d) the archival agency shall have general supervision over the care, preservation, and disposal of the records of all departments, agencies, and institutions of the state government.[23]

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[23] C. C. Crittenden, "Some Problems of State Archival Administration," *The American Archivist,* vol. 4 (1941), p. 262. For a model public records act, see "The Proposed Uniform State Public Records Act," *The American Archivist,* vol. 3 (1940), pp. 107-115.

THE STATE OF THE DAILY PRESS OF LONDON BETWEEN 1858 AND 1861 WITH SPECIAL REFERENCE TO THE ITALIAN QUESTION

H. Franklin Williams
University of Miami

The use of newspapers as historical sources is a comparatively recent development. As late as 1908 James Ford Rhodes felt it necessary to read a paper to the American Historical Association justifying the employment of newspapers in the writing of history.[1] Today no such justification is necessary. Indeed, the historian in many instances *must* use newspapers if his documentation is to be complete. As a consequence many historians have made hasty use of the press without considering how difficult it is to make sound use of newspapers as historical sources.

Two types of research call particularly for the study of newspapers. One is *research in social history,* in which the newspaper offers a mass of minute data which escaped record elsewhere. Here the historian is faced by the problem of selection. Except for bulk, newspaper sources do not differ from other types of historical material. *Research in opinion* is the second field in which newspapers are particularly useful. But here the historian is beset by many problems. He may wonder whether the press leads or follows public opinion. And for every expression of opinion he should know what bias may be displayed. Too often research of this type ends in a series of abstracts of newspaper comment, without an estimate of the bias or of the importance of the articles quoted. This error might be avoided if the historian were to preface his research by a preliminary study of the press which he plans to use. This paper presents an example of such a study, examining the daily press of London as preparation for a consideration of English reactions to the unification of Italy.

The great period of the press in London began with the Crimean War. About that time the newspapers underwent a two-fold development: on the one hand they expanded physically, and on the other they increased their influence. The physical change was due partly to an improvement of printing-presses and partly to the removal of governmental restrictions. Taxation of advertisements was given up in 1853; the stamp-tax disappeared in 1855; and finally the repeal of the paper duty was pushed through in 1861.[2] These changes made cheap newspapers possible, and thus widened the audience and increased the importance of the press. By 1858 London had three important penny newspapers (the *Morning Star,* the *Daily Telegraph,* and the *Standard*). The majority of newspapers, however, still brought three or four pence unstamped and four or five pence stamped. The optional stamp entitled the paper to travel through the post for fourteen days without further payment. The second change in the press—its increase in influence—was based on the increasing independence of editors. Newspapers had long been regarded as the organs of parties or factions or individual statesmen. Some of them still partook of that character in the years between 1858 and 1861; for example, the *Morning Star* was the organ of the Manchester School leaders. But politicians had learned that control of a newspaper has its unpleasant aspects. An official organ is an expense; its views are discounted for prejudice; and all that appears in it can be blamed on the sponsor. In the 1850's the *Times* led the way to a new system. During the Crimean War it had been not the creature of one party, but the arbiter between parties. Between 1850 and 1860 politicians tended to divest themselves of direct interest in newspapers and to seek subtler methods of exerting influence. In 1854 the Peelites sold their paper, the *Morning Chronicle.*[3] Disraeli in 1858 gave up his interest in the Conservative weekly, *the Press.*[4] Napoleon III abandoned his attempt to obtain an organ in London after a quarrel with Serjeant Glover, who bought the *Morning Chronicle* in 1854.[5] Politicians tried instead to win the feelings of editors by opportune communications of information. When Napoleon III undertook to influence the English press in favor of Italy he asked Cavour to furnish documents showing Austrian "crimes" in Italy.[6] The effect of the emancipation of the newspapers from political control was to increase the competition between them, for the new type of owner wanted to make a profit in cash rather than in political capital.

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[1] James Ford Rhodes, "Newspapers as Historical Sources," *Historical Essays* (New York: Macmillan Co., 1909), pp. 81-97.

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[2] James Grant, *The Newspaper Press: Its Origin, Progress, and Present Position* (3 vols.; London: Tinsley, 1871-2), vol. 2, pp. 298-322.

[3] Henry E. Carlisle (edit.), *A Selection from the Correspondence of Abraham Hayward, Q. C., from* 1834-1884 (2 vols.; London: Murray 1886), vol. 1, pp. 251-2.

[4] William F. Monypenny and George E. Buckle, *The Life of Benjamin Disraeli, Earl of Beaconsfield,* (2 vol. edit.; New York: Macmillan, 1929), Vol. 1, pp. 1307-1321.

[5] Grant, *op. cit.,* Vol. 1, p. 312.

[6] *Il Carteggio Cavour-Nigra dal* 1858 *al* 1861 (4 vols.; Bologna: Zanichelli, 1926-9), Vol. 1, pp. 211 ff.

The morning papers went to press in the small hours of the morning and were published in a first edition by eight o'clock. Most of them had later editions, which sometimes contained foreign dispatches which arrived during the morning. Several of the morning papers had, associated with them, evening papers under the same or different names. All the papers looked much the same, for the *Times* served as a model to all.[7] Each one had an outside sheet of advertisements. These advertisements were small notices, much like the classified advertisements in a modern American newspaper. They were so unimportant as a source of income that some of them were omitted when room on the outside sheet ran short. Each newspaper had several sheets of news material made up of police reports, accounts of unusual happenings (contributed by the free-lance reporters known as "penny-a-liners"), and excerpts from provincial and foreign papers. Regular features were a communication from a "City correspondent" with the financial news, and a report of the Parliamentary debates of the preceding day. But the heart of the paper lay in the two central pages where were found the leading articles, the political news, and the important dispatches from foreign countries. Each paper had its particular friends, who supplied it with political information. Most of them maintained a Paris correspondent, and many had their own correspondents in other capitals. These representatives sent letters that were newspapers in miniature. They also used the telegraph on occasion, although Reuter's new news service, founded in 1858, was beginning to furnish most of the telegraphic material.[8] The leading articles combined a summary of important news with editorial comment and often a dash of prophecy. Leading articles were always unsigned, a fact which often aroused suspicion and criticism. The most famous case of this sort came after the period covered by this study. It was the controversy between Cobden and the *Times* in 1863.[9] The paper stood or fell on the contents of its central sheet of political and foreign correspondence and leading articles.[10]

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[7] Stanley Morison, *The English Newspaper, Some Account of the Physical Development of Journals Printed in London between* 1622 *and the Present Day* (Cambridge: University Press, 1932), pp. 207 ff.

[8] Grant, *op. cit.*, Vol. 2, pp. 323-51.

[9] Sir Edward Cook, *Delane of The Times* ("Makers of the Nineteenth Century"; New York: Henry Holt and Co., 1916), pp. 161-8. John Morley, *The Life of Richard Cobden* (1 vol. ed.; London: T. Fisher Unwin, 1903), pp. 884-903.

[10] This paragraph is based on Grant, *op. cit.*, vol. 2, chap. 11, *passim*, and on examination of newspaper files.

One paper, the *Times,* dominated the press of London so completely that no competitor could approach it. Its editor, John Thadeus Delane, had been given a free hand by the owner, John Walter, II. Delane, by a remarkable series of "scoops," had made the *Times* so successful that it could outbid its competitors for the services of the best reporters, correspondents, and leader-writers. Its prestige and the social contacts of Delane brought it all sorts of political information. This, in turn, increased its power again. In 1858 it maintained correspondents at Paris, Vienna, Turin, Constantinople, and Cairo; there were special correspondents in India and China. In 1859 it had, in addition, correspondents in Rome, Naples, and the Ionian Islands. So great was its advantage over other newspapers in this respect that it felt, at first, no need of subscribing to Reuter's telegraphic news services. Within a few months, however, it became a subscriber.[11]

The *Times* was at the service of no party but was courted by all. The courting took the usual form of the time, the communication of information. The editor used the information, but expressed his own opinion. Through the story of Delane and his paper move all the great figures of the period. Lord Granville, Lord Derby, Charles Greville, Disraeli, Henry Reeve, Robert Lowe, and a host of others served him as informants or as writers.[12] He was often assailed as possessing excessive power in politics, a charge which is plausible when we find Palmerston and Clarendon offering him lame explanations of their visit to Napoleon III late in 1858,[13] and Napoleon III himself sending Delane a letter which only a few of the Cabinet had seen.[14] Once the *Times* drew the fire of the Queen when it published words which she had used in confidential conversation with Granville.[15]

The *Times* was not subject to any party influence, but it was not prevented from expressing opinions on politics and foreign affairs. Between 1858 and 1861 its attitude was watched with care by foreign statesmen, for it was regarded as the surest guide to the state of English opinion. Whether this was because it formed that opinion or because it reflected it, men were unable to determine.[16] There is some evidence that Delane attempted to conform to public opinion, or at least not to flout it.[17] But the *Times* was often at odds with public opinion, as it was, for example, in the early stages of its Italian policy. On the whole it tended always to conform with some independence to the policy of the government. This was particularly the case when Palmerston was in power from 1855 to 1858 and from 1859 to 1865. Delane was on intimate terms with Palmerston, receiving and giving information.[18] Palmerston thought so highly of Delane that in 1861 he offered him an Under-Secretaryship.[19] But the *Times* was independent enough to be hostile to Napoleon III when Palmerston was on good terms with the French Emperor. In 1858 Palmerston suggested in vain that the *Times* should be more moderate in its criticisms of Napoleon III.[20] Lord Derby, when Prime Minister had made the same suggestion through Greville.[21] Delane did not yield.

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[11] Grant, *op. cit.,* vol. 2, p. 330.

[12] Cook, *op. cit.,* pp. 118, 213, 13, 246, 12, 196, and *passim.*

[13] Arthur Irwin Dasent, *John Thadeus Delane, Editor of the "Times": His Life and Correspondence* (2 vols.; London: John Murray, 1908), vol. 1, pp. 303-4.

[14] Cook, *op. cit.,* p. 124.

[15] Lord Edmond Fitzmaurice, *The Life of Granville George Leveson Gower, Second Earl Granville, K. G., 1815-1891* (2 vols.; London: Longmans, Green, & Co., 1905), vol 1, pp 341-2.

In its treatment of Italian affairs the *Times* was influenced by its distrust of Napoleon and a dislike of Prussia, so that it naturally tended to support the Austrian point of view in 1858 and 1859. The Italian patriots took this to mean that the *Times* was anti-Italian and blamed its correspondents in Italy, Hardman and Gallenga.[22] But Austria's arbitrary action in 1859 and Napoleon III's turn against Italy helped to bring the *Times* to the Italian side. The change was clear by autumn of that year, when Delane visited Italy.[23] There seems to be no evidence that any Italian patriot had any way of influencing the *Times*, unless it was through Palmerston. Napoleon's efforts to do so were useless.

The nearest rival to the *Times* was the *Morning Post*. In 1858 W. J. Rideout inherited the ownership of this paper. He left it in the hands of the capable editor, Algernon Borthwick, whom he made irremovable and to whom he allotted one-third of the profits. The *Morning Post* sought to attain the character of the *Times*, but was popularly regarded as a journal of social gossip. But what really weakened its position was the fact that it was known as the organ of Palmerston, although he had no share in its ownership. It had not the independence of the *Times* and did not attain great influence until the death of Palmerston in 1865. The leading articles before that time were reputed to be merely polished versions of Palmerston's memoranda to Borthwick. The importance of the influence is obvious from memoranda published in Borthwick's biography.[24] Borthwick was also supposed to be in the pay of Napoleon III. Malmesbury stated this as a fact, citing Walewski, Napoleon's ambassador and foreign minister, as authority.[25] Certain it is that the *Morning Post* received favors from the French, especially while Borthwick's friend Persigny was French ambassador in London. Thus the *Morning Post* received Napoleon's letter to Persigny of July 27, 1860, before the other papers. There were many instances of such French favor to the *Morning Post.*[26]

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[16] B. Kingsley Martin, *The Triumph of Lord Palmerston, a Study of Public Opinion in England before the Crimean War* (London. Allen and Unwin, 1924), p. 88.

[17] Cook, *op. cit.*, p. 201.

[18] *Ibid.*, p. 100.

[19] Dasent, *op. cit.*, vol. 2, p. 26.

[20] Dasent, *op. cit.*, vol. 1, p. 305.

[21] William Dodgson Bowman, *The Story of "The Times"* (London: Routledge, 1931), pp. 225-6.

[22] Giuseppe Massari, *Diario,* 1858-60 *sull 'Azione Politica di Cavour* (Bologna: Cappelli, 1931), pp. 172, 196, 200, 201.

[23] Cook, *op. cit.*, pp. 121-2.

The *Morning Post* showed no great originality on the Italian question. Borthwick knew Massimo d'Azeglio, but that statesman was not in the main current of events in these years. The paper sent a correspondent, Willung, to the war in Italy.[27] For the rest it followed the line of Palmerston. For that reason it was carefully read abroad. The *Morning Post* later became an arch-conservative organ, and this attitude underlay its Palmerstonianism from the start. It clung to protection long after 1846.

More important than the *Morning Post* in aggregate numbers was the group of newspapers owned by James Johnstone. It included the *Morning Herald*, the *Evening Herald*, the *Standard*, and the *Evening Standard*. He kept the four papers because it occurred to him in 1858 to operate the *Standards* as penny papers while retaining his better clientele with the fourpenny *Heralds*. The combination worked well, for the *Herald* survived as a "considerable" paper until 1869, while the *Standard* built up a large circulation.[28] The papers were operated on a comparatively modest basis. They used the same news, but with different leading articles.[29] In 1859 they had special correspondents only in Paris and Egypt. For remoter news, such as that from India, they published the Foreign Office dispatch.

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[24] Reginald Lucas, *Lord Glenesk and the "Morning Post"* (London: Rivers, 1910), chap. 4, *passim*.

[25] Earl of Malmesbury, *Memoirs of an Ex-Minister, an Autobiography* (2 vols.; London: Longmans, Green, and Co., 1884), Vol. 1, p. 362.

[26] Lucas, *op. cit.*, p. 183-5; T. H. S. Escott, *Masters of English Journalism, a Study of Personal Forces* (London: Unwin, 1911), p. 189.

[7] Massari, *op. cit., p.* 319.

[28] Grant, *op. cit.,* vol. 1, p. 329.

[29] Escott, *op. cit.*, p. 197.

In politics these papers were devoted to official Conservative views. Before the Crimean War the *Herald* had been regarded as the organ of the Conservative party, although Disraeli denied that it was his paper.[30] In 1857 Malmesbury had an interview, on behalf of Lord Derby, with a new editor "to arrange as to the line to be taken" by the *Morning Herald*.[31] As late as December 5, 1858, the Duke of Newcastle assumed that the Derby government had inspired an announcement in the *Herald*.[32] These papers were almost alone in representing the Conservatives. There seems to be no evidence of any foreign influence on these papers except for the inadequately supported rumor that Napoleon paid them.[33]

The *Morning Chronicle* was by 1858 moribund (it died in 1862), but it enjoyed some remnants of its former prestige. It had been a great liberal paper before 1843 and had then belonged to the Peelite and Puseyite group of Newcastle, Herbert, and Gladstone until 1854. It had been purchased by Serjeant Glover, had ceased to represent the Peelites, and had lost the services of Abraham Hayward, its best writer. Glover made a bargain with Napoleon III to put it in the French service, but fell out with the Emperor and revealed the bargain. This finally destroyed the reputation of the paper. More fortunate was the *Morning Chronicle's* evening version, the *Globe*. It had enjoyed the favor of Palmerston in the forties and that of Granville in 1852. It had become independent and remained one of the best of the evening papers, being read particularly for its excellent foreign news.[34]

The group which had controlled the *Morning Chronicle* until 1854 was represented during the period 1858-1861 by the *Daily News*. This paper, once edited by Charles Dickens, was edited from 1858 to 1869 by T. Walker. It was known to voice Gladstone's opinions and became, a few years later, the official Liberal paper. It was then that it gained its greatest reputation, but even in 1858 it was carefully read in England and on the Continent.[35] The *Daily News* was the apostle of liberty abroad as of liberalism at home. It sided with the

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[30] Dasent, *op. cit.*, vol. 1, p. 148..

[31] Malmesbury, *op. cit.*, vol. 2, p. 73.

[32] Carlisle, *op . cit.*, vol. 2, p. 19..

[33] Escott, *op cit.*, p. 200.

[34] This paragraph is based on Grant, *op. cit.*, vol. 1, pp. 311-12.

[35] Massari, *op. cit.*, pp. 11, 227. Monypenny and Buckle, *op. cit.*, vol. 1, p. 1623.

North in the American Civil War and with Italian nationalism. Even Mazzinians, such as Jessie White Mario, contributed to the *Daily News*.[36] During 1859 it added to its prestige by excellent war correspondence. Count Carlo Arrivabene, who had written for it in London, was sent to northern Italy. Cavour, who was pleased by the attitude of the *Daily News*, gave him special letters and opportunities.[37] The *Daily News* was Italy's surest friend among the London newspapers.

The disadvantages of a party journal were clearly shown by the fate of the *Morning Star*. It was organized to express the views of the Manchester School, although Cobden and Bright were not directly involved in its management, unless the fact that Bright's brother-in-law was editor be regarded as involvement.[38] It did express those views and with such persistence and monotony that it never achieved a large circulation, never more than 15,000, although it was a penny paper.[39] Free trade and peace at any price were not principles which would lead it to favor the course which Italian unification took between 1858 and 1861. The commercial treaty with France in 1860 was more to its taste.

Two moderate liberal papers remain to be discussed. The *Morning Advertiser* had a large circulation among innkeepers and Members of Parliament. It had long been merely the organ of a society of licensed victuallers, but under the editorship of James Grant it was gaining a wider audience. In 1858 Napoleon bracketed it with the *Times* and the *Morning Post* as one of the great papers to which material should be supplied.[40] The editor described it as "consistently Liberal and thoroughly Independent."[41] In foreign affairs this meant hostility to Napoleon III and to Austria, and sympathy for Italy. Similar views were expressed by the *Daily Telegraph*, the other liberal paper. It was the first of the penny papers. Founded in 1855, it had established its low price in the same year. By 1858 it had not gained much influence, but the owner, Joseph Moses Levy, had gathered a brilliant staff for his paper. By 1870 it was able to boast the largest circulation in the world.[42] It obtained its audience among the middle classes and maintained its liberal policy for their benefit. It was hardly known abroad.

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[36] Miriam B. Urban, *British Opinion and Policy on the Unification of Italy* (Privately Printed, 1938), p. 79.

[37] Luigi Chiala (edit.), *Lettere Editee ed Inedite di Camillo Cavour* (6 vols.; Turin: Roux & Favale, 1883-7), Vol. 3, pp. 59-60, 82-3, 163.

[38] Justin McCarthy, *Portraits of the Sixties* (London: Unwin, 1903), p. 111.

[39] Grant, *op. cit.*, vol. 1, pp. 376-9.

[40] *Il Carteggio Cavour-Nigra dal* 1858 *al* 1861 (4 vols.; Bologna: Zanichelli, 1826-9), vol. 1,, pp. 211-12.

[41] Grant, *op. cit.*, vol. 2, p. 63.

The state of the press may be summarized, as far as political influence is concerned, by indicating to what newspaper each of the important leaders would turn if he wished to express his views. On the Conservative side, the party leader, Lord Derby, was an old-school politician, who disliked the press[43] and the *Times* in particular. If it was necessary to speak in a newspaper, he chose the *Morning Herald,* as did his colleague Lord Malmesbury. Disraeli hoped to win the *Times,* but the friendship was a troubled one. He had a reliable weekly paper, the *Press,* at his service. On the Liberal side, all the leaders could use the *Morning Advertiser* and the *Daily Telegraph,* but had no control over them. Russell, like Derby, disliked the press, and the feeling was reciprocated, especially by the *Times.* Palmerston could count on the *Morning Post* and often used the *Times.* Lord Granville and Lord Clarendon were friendly with Delane and usually agreed with the *Times.* Gladstone was disliked by the *Times,* but had a sure medium in the *Daily News.* Cobden and Bright were at war with all the press but their own *Morning Star.*

Foreign influence on the press was small, except where English leaders consented to use their influence on behalf of a foreign cause. Austria had no desire to influence the press and did not know how to work with a free press. The foreign statesmen who knew how to use the English press were Napoleon III and Cavour. The Emperor had real influence over the *Morning Post.* Cavour found the *Daily News* the most friendly of the papers. By furnishing them usable material they could occasionally obtain a hearing in other papers, but they could not count on them.

The fact which emerges most clearly from this survey is that the daily press of London was rapidly achieving independence in the years between 1858 and 1861. Newspapers might have a Liberal or a Conservative tendency, but few of them were committed to one leader or one faction. The *Morning Star,* the *Morning Post,* and to a smaller degree the *Daily News* were subject to influence subversive of their independence. In the next decade these, too, became independent or disappeared. The Fourth Estate came into existence.

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[42] *Ibid,* p. 96.

[43] Malmesbury, *op. cit.,* vol. 2, p. 73.

RELATIONAL EMERGENTS

ELLIS FREEMAN
University of Tampa

The problem with which this paper deals has its origin in psychology, where it was acutely sensed long ago. More recently it has arisen in the other natural sciences, particularly in physics. It belongs, accordingly, in the fundamental discipline underlying all the natural sciences, namely the Philosophy of Science.

In the broadest sense the problem consists in determining the character of a certain type of cause and effect which has stubbornly resisted the mechanistic interpretation of tradition. The physicists, in their normal condition of unregenerate philosophical naiveté, have generally been oblivious of its existence. The psychologists, on the other hand, driven by the peculiar nature of the material of their science, and being, moreover, less blinded by traditional philosophical misconceptions and ineptitudes, have at least been acutely aware of the difficulty, and what is more, have made some stumbling efforts toward its solution. This paper is one more such an attempt by a psychologist to bring the solution of the problem perceptibly nearer.

From Aristotle to the physical scientists of our time, the fallacious assumption has been made that any complex phenomenon, taken as an effect, was to be entirely and satisfactorily explained by the summation of the properties of the component parts or antecedents, taken as the cause. Thus, the molecular weight of water (18) was, and still is, adequately accounted for by the summation of the corresponding properties of its components—two atoms of hydrogen with atomic weight of 1, and one atom of oxygen with atomic weight of 16. As this cannot be disputed, it has served as the stereotype for the explanation of all other properties of water also—that is, when it happened to occur to the physicist that any further explanation was called for, which was rare indeed.

For convenience, I shall use the term *resultant* to designate such mechanistically determined properties of complexes—properties that can be explained simply by a summing up of the corresponding properties of the component elements or parts of the complex. Properties of compounds or complexes which fall into the categories of weights and extents appear to be resultants, satisfactorily accounted for by this mechanistic explanation. Since the physical scientist is essentially a creature who weighs and measures, he has either overlooked another class of properties, or has comfortably assumed that this other category would be similarly explained when more is known.

Unfortunately for this view, there is reason to suppose that this second class of properties—for example, in the instance of water, its freezing and boiling points, its anomalous expansion, its surface tension, and even its specific gravity—will continue to resist all efforts to treat them as resultants. Increased knowledge of the properties of oxygen and hydrogen atoms has brought us no nearer to an ability to predict the above-named properties of their compound, water. Again for convenience, I shall designate such properties of the complex whole as are not mechanistic summations of the properties of its parts as *relational emergents,* or more simply as *emergents.*

The issue, for the natural sciences as a whole, may be best presented by considering a simple effect in psychology which does not yield to a mechanistic explanation based on summation of properties, but which appears instead to constitute an emergent. In a simple perception, such as that involved in seeing a green piece of paper, one has a right to ask the mechanist what there is in the properties of the preconditions of this phenomenon that can be *added* to give the experience of green as a *resultant.* The first precondition or cause of "green" is the stimulus—an electromagnetic disturbance of about 520 millimicrons wave-length. There is nothing of "green" about the properties of this stimulus is sufficiently established by colorblindness. Likewise, in the ensuing neural process in the retina, optic nerve and brain there is nothing of "green." Just as the stimulus is itself merely an electromagnetic disturbance entirely destitute of the property of "greenness," so the neural process is merely an electrochemical disturbance from beginning to end likewise destitute of the property of "greenness." There is nothing in the summation of the properties of the stimulus and the ensuing neural processes that causes or results in the perceptual effect known as "green" which in any manner contains or accounts for that effect. In other words, this greenness is an *emergent,* something wholly new, and not a *resultant,* which is something old and already given, in the sense that it requires merely a summation of constituent parts to form a mechanistic whole.

From a very early day the psychologist has at least recognized something troublesome in connection with the effects that are here distinguished as emergents, because the essential material of psychology is precisely this kind of phenomenon. It is not to be wondered at that the physicist has failed to recognize the existence of this second class of effects, requiring a supplementary category of cause or explanation, for physics is so filled with effects which are clearly resultants that the student in this field could well occupy himself solely with summative effects and still be busy for a lifetime.

Finding that summation of the properties of preconditions could not explain an effect such as "green," and knowing no other kind of explanation, the earlier psychologists resorted to shuffling evasions and dodges. Typical of these is Liebnitz's theory of Psychophysical Parallelism, which is still widely taught by uncritical teachers to helpless students. This theory boils down to the strange notion that the "greenness" of our perception has no necessary connection with the preconditions in the physical world, namely with the stimulus and the neural processes, but merely happens by some divine preordination to be synchronized with those preconditions. It is a singular commentary on the ingenuity and at the same time the deficiency of judgment of psychologists that they should have been satisfied with the notion of one set of events for the physical world and a distinct but parallel set for the mental world, when at every hand nature provides simple and overwhelming evidence of its unitary order. Any scientific explanation, including any psychological explanation, of such phenomena as "greenness" must accept the unity of nature as its foundation.

A simple explanation, that accords with the uniqueness of "greenness," calls for no special status for the mental, and provides a pattern for explanation of emergent relations in general, may be formulated somewhat as follows. The wave-length 520, impinging on the retina, comes into interaction or relationship with the latent electrochemical forces of the retinal substance. From this interaction something entirely new emerges—something that is not to be found already existant partly in the stimulus and partly in the retina. This new thing is the electrochemical process that now commences in the retina, and which is not to be explained as a summative or mechanistic effect of the properties inherent in the stimulus and in the retina. It is neither the one nor the other, nor the algebraic sum of the two. It is, in fact, totally new, being derived from the newly established *relationship* set up by the coming together of the stimulus and the retinal potentialities. This new phenomenon may be called a *relational emergent,* or simply an *emergent.*

The denial that the emergent produced is an algebraic sum of the properties of stimulus and retina is not a denial that a particular wave-length, 520 millimicrons, and a particllar retina are necessary and sufficient causes or preconditions of the experience of "green." They are necessary, and therefore causes; without them the phenomenon of "green" could not occur. But to concede this is very far from saying, with the mechanists, that the properties of wave-length 520 millicrons and a retina of a certain constitution add up to "green."

Now this first emergent, the electrochemical impulse in the optic nerve fibers, in turn operates as a cause or preconditional element when it reaches the projection areas of the cerebral cortex. Here the impulse comes into conjunction with certain latent properties of the cortical cells, and from this conjunction arises a still newer and equally unique emergent, the sensation of "greenness." This "greenness" is neither the impulse in the nerve pathways, the responsive activities of the cortical cells, nor the algebraic sum of any or all of the properties of nerve or cortical cell activity.

In more general terms, then, all perceptions, and all overt responses of muscles and glands as well, can be best explained as *emergents,* caused by antecedent *emergents* as necessary preconditions, but not comprised of a summation of properties of these preconditions. Indeed, no *emergent,* taken anywhere in the continuous chain of causality, is to be accounted for as a mere summation of the properties of its antecedents, but is something unique and initially unpredictable from these antecedents.

A concluding example from the physical sciences may help to clarify this presentation. At normal temperature and pressure, hydrogen and oxygen are gases. If we imagine a physicist who knew all the properties of these two gases, but who at the same time was wholly unacquainted with water, we can see that it would be impossible for him to define any of the properties of water except its molecular weight, even if he were told that it consisted of two atoms of hydrogen joined to one of oxygen. He could not predict the liquid state of water at ordinary temperatures and pressures, its boiling and freezing points, its anomalous expansion, its viscosity, or its surface tension, for the same reason that since water is an *emergent* of hydrogen and oxygen in the relationship of combination, it is something unique that cannot be derived *a priori* from the properties of its component substances. In brief, just as the stimulus wave-length 520 millicrons and the retina and optical nerve and cortical cells are one thing, while the "greenness" that results from their relation is an altogether different thing, so oxygen and hydrogen are one thing, and water a new and unpredictable emergent that arises from their coming together.

AN EARLY INDIAN CLAM BAKE

R. B. Becker
Florida Agricultural Experiment Station

A few years ago, a visit was made to an Indian campsite, which was preserved to a remarkable degree despite the long time since its abandonment. This campsite was located in Walton County within sight of the Gulf of Mexico some distance from U. S. Highway 98. Now for the narrative.

Before white man's history of the event, an Indian settlement was located at the junction of Eastern Lake and the Gulf of Mexico. The campsite was an ideal one. Eastern Lake supplied fresh water, while the salt waters of the gulf provided sea foods. The campsite was located about a large live oak with the campfire farther inland from the gulf. Under the spreading branches of the oak, the Indians dug pits into the reddish-brown sand-clay soil down onto the hardpan subsoil and heated these pits with fire. After these pits were heated throughly, moist white sand from the shore was placed in the hot pits, whole clams (poquauhocks or "quahogs," a variety of *Venus mercenaria* Linn.) in the shells were placed above the moist sand, and the live clams covered over with hot ashes. Numerous clam bakes had been prepared under this great tree. During such a clam bake a storm swept in off the gulf. Waves and wind drove the Indians inland, and covered the campsite with a sand dune. The sand buried the roots of the great oak so deeply that it died. The trunk and branches decayed, and wasted away, but the trunk and roots remained, preserved by a deep cover of dune sand. Years or perhaps centuries later, Mr. W. Westerly and his bride entered on a 160 acre homestead bordering on the Gulf of Mexico and including this exact site. Their cabin was built about 500 yards inland from the old sand dunes, the sands of which had shifted to expose the trunk of the old tree. They "proved up" on the homestead and later moved a few miles away to Point Washington on Choctawhatchee Bay.

About a quarter of a century passed. In 1926 another storm lashed the waters of the Gulf. Waves and wind removed a part of the large dune and exposed the ancient Indian campsite. A few persons who fished, or hunted crabs on the gulf picked up flint arrows and fairly large pieces of broken Indian pottery on the campsite.

On December 21, 1931, the author visited this ancient campsite accompanied by the elder Mr. Westley and his sons Arthur and Edgar. A casual survey of the site was made in search for Indian relics. The search yielded nine arrow points, a small bone needle, piece of quartz, two rough bird points, a broken arrow, two small worked flints and a selection of broken pottery from the numerous fragments scattered about.

It was possible to distinguish the original level of the Indian camp by pieces of flint, the arrow points, broken pottery and fire sites. Where the sand had blown and washed away from part of the dune, a portion of the terraine was below the old camp level. This was shown by debris being on the surface only. In other places a layer of beach sand of a different color covered the campsite. A fire site, about 7 x 9 feet in dimensions, revealed by its rounding surface and a deposit of ashes mixed with sand, was excavated. Broken parts of two pots too fragmentary for restoration were found in these ashes, as was also a rounded and worn fragment of coral. The find of greatest interest was discovered next.

At an intersection of the present terrain with the level of the old campsite, Arthur Westley and the author began to excavate. The sites of six clam bake pits with whole clam shells, were found together, and two others near them. Each of these was identical in outline and structure, indicating the method used by the Indians in preparing this repast. The pits were 7 to 10 inches across, and deeper than the diameter. Sand had been removed and a fire or burning coals placed therein to heat the pit. When the fire had burned down, the cavity was filled level with white beach sand and the whole clams placed over the top. (It is believed that the white beach sand was *wet,* and that the clams were *steamed*). One of the whole clams was taken for identification. It was variety of the quahog *Venus mercenaria* Linn.

Another hurricane moved across the Gulf and went inland near Eastern Lake in the summer of 1936. High tides swept the waves of the Gulf over the campsite. Beach sands were swept inward. When the waves receded, the coastline was one-eighth mile farther seaward than in 1931.

The old campsite was visited again on September 3, 1936. Beach sands covered so much of the earlier campsite level, that only here and there were any traces of Indian occupancy evident. A few small fragments of Indian pottery and a single broken flint arrow were secured. The southern face of the old dune had washed away, leaving the few remaining roots of the old live oak tree exposed. The surface soil of the campsite had been washed away at this point exposing the hardpan subsoil. Numerous discolored spots in the dark organic hardpan showed where many clam feasts had been steamed. At only two

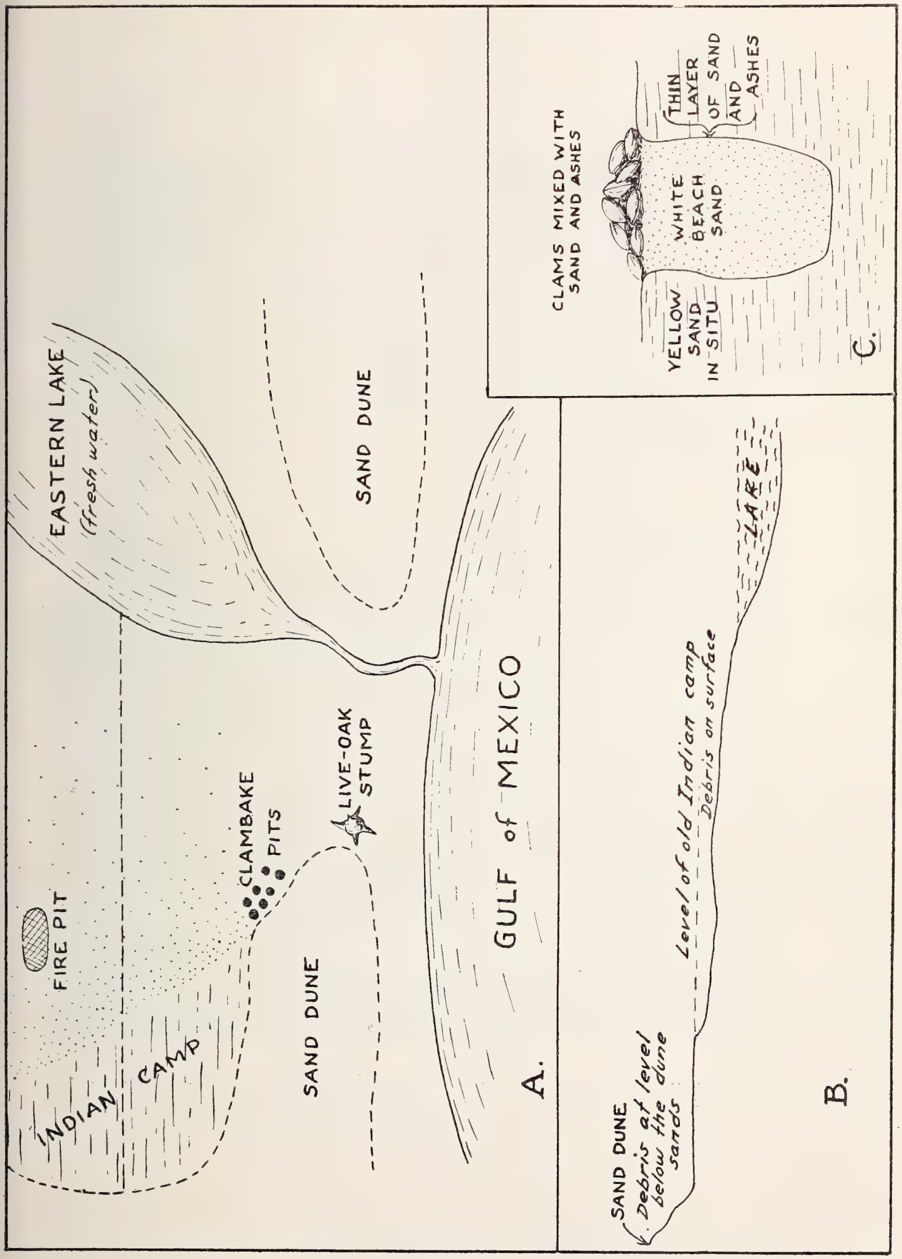

Figure 1—Sketch of Indian campsite showing features exposed prior to last hurricane. A—Plan, B—Profile, not drawn to scale. C—Cross-section of clambake pit.

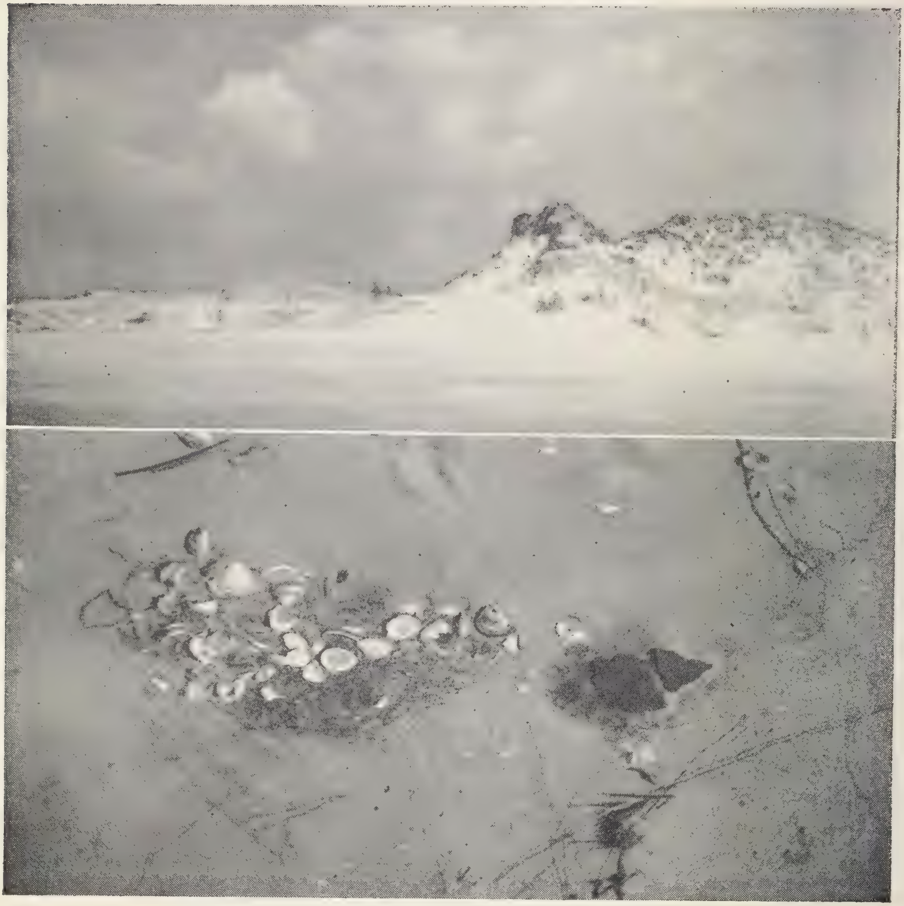

Figure 2.—Indian campsite. Upper—A part of the sand dune remaining southeast of Eastern Lake after the second hurricane. Lower—Scattered remains of an Indian clambake at the campsite, with two pieces of broken pottery, after the second hurricane.

points were the empty shells of such a bake still intact with the original ashes. Two fragments of Indian pottery lay by one of these. A photograph taken for record, accompanies these observations.

Thus was pieced together a part of the camp life of some American Indians prior to the influence of white men. The forces of Nature which once preserved the site are destroying it again by the action of wind and waves and the shifting of the sands along the gulf coast.

QUANTITATIVE CRITERIA FOR THE APPLICATION OF NORMAL GRADING SYSTEMS

Richard J. Anderson
University of Florida

The successful application of the normal distribution curve, through the use of tables of areas under the curve, to problems involving probability of occurrence, and for the prediction of distributions, has resulted in the development and dissemination of systems assigning academic grades on the basis of percentages obtained from the normal curve. These normal grading systems gain further prestige from the demonstrable facts that human traits such as height, weight, intelligence, and therefore by inference, academic ability and achievement, very closely approach normal distribution if sizable, representative samples are taken.

Of the many normal grading systems offered, the one obtained by using the standard tables of areas under the normal curve and dividing the group into five letter grade groups of unit standard deviation size is almost universally recognized as the most conventional scheme to adopt. It gives the grade C a percentage of 38 (the percentage of the area within .5 standard deviation on either side of the mean), B and D percentages of 24 each, (the percentages of the area between .5 and 1.5 standard deviations on either side of the mean), and A and E each percentages of 7 (corresponding to the remaining extreme areas). This system is the one with which we shall be concerned, although the method introduced could be applied to any such system.

Those who have had experience in assigning grades on the basis of scores which can be ranged in a single distribution, have developed criteria for interpreting the degree of conformity to a normal grading system which may be expected. However, people who are less familiar with the topic are often perplexed by the high degree of precision in the derivation of normal grading systems and the apparently incongruous, large deviations from the fixed theoretical percentages which are usually experienced. Textbook discussions of the topic of normal grading systems are of little use to one in investigating the degree of conformity to be expected. They usually give merely the precise statistical derivation of the system or systems in question, and then either rigid endorsement, or some general statement to the effect that conformity will not be too high if the group is too small.

The problem of comparing an experienced distribution with one theoretically derived from fixed assumptions is easily solved by application of the Chi Square test. This determines whether or not the deviations are too large for mere chance fluctuations by obtaining the probability of occurrence of so large a value of this measure of deviations, called Chi Square. The method to be presented considers the opposite aspect of the problem. Using A-7 per cent, B-24 per cent, C-38 per cent, D-24 per cent, E-7 per cent as our theoretical distribution, we shall compute deviations so as to obtain the greatest possible value of Chi Square having a probability of occurrence greater than 0.1. The probability 0.1 is chosen because Chi Square probability of 0.1 is considered as not contradicting the theoretical assumptions.[1] Any useful probability could be taken, but 0.1 will give the largest universally acceptable deviations, and therefore, provide criteria in the form of limiting distributions. In considering deviations we shall consider all possible situations of maximum and minimum concentration of single or paired letter grades for a group of 100, and consider only single letter concentrations for a group of 200 to show the effect of size. A group of one hundred is chosen as the smallest group to which normal grading systems can reasonably be applied, and also, because of the frequent occurrence of groups of this size. Furthermore, this permits immediate realization of the percentage distribution. For a fixed group of any size, with five categories and $P=0.1$, the value of Chi Square is 7.779. Thus, any distribution from which we obtain a value of Chi Square less than 7.779 will be consistent with our assumed distribution of 7, 24, 38, 24, 7.

The following example will serve to illustrate the computation:

f_t=theoretical frequencies
f_p=experienced frequencies

$$\text{Chi Square} = \Sigma \frac{(f_p - f_t)^2}{f_t}$$

	f_t	f_p	$f_p - f_t$	$(f_p - f_t)^2$	$\frac{(f_p - f_t)^2}{f_t}$
A	7	14	7	49	7.000
B	24	22	—2	4	.167
C	38	36	—2	4	.105
D	24	22	—2	4	.167
E	7	6	—1	1	.143
					Chi Square=7.582

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[1] John F. Kenny, *Mathematics of Statistics*, Pt. II (New York. D. Van Nostrand Co., 1939), p. 169. This work will serve as a general reference to the subject treated in the present paper.

This illustration maximizes A's. Since the deviations are squared we need but change the signs of the deviations to minimize A's. Also, because of the symmetry of the assumed distribution, from this single computation we can also draw maximum and minimum E's.

The following tables with Chi Square values given, show how far our experienced distributions may deviate from the fixed percentages. Parentheses indicate alternate figures.

GROUP I

N = 100 P = 0.1 Chi Square < 7.779

MAXIMUM AND MINIMUM A OR E (7.582)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum A	14	22	36	22	6
Minimum A	0	26	40	26	8
Maximum E	6	22	36	22	14
Minimum E	8	26	40	26	0

MAXIMUM AND MINIMUM B OR D (6.653)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum B	6	35	33	20	6
Minimum B	8	13	43	28	8
Maximum D	6	20	33	35	6
Minimum D	8	28	43	13	8

MAXIMUM AND MINIMUM C (7.298)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum C	5	19(20)	51	20(19)	5
Minimum C	9	29(28)	25	28(29)	9

MAXIMUM AND MINIMUM A AND E SIMULTANEOUSLY (6.820)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum A and E	12(11)	22(21)	34	21(22)	11(12)
Minimum A and E	2(3)	26(27)	42	27(26)	3(2)

MAXIMUM AND MINIMUM A AND C, OR E AND C SIMULTANEOUSLY (6.868)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum A and C	9	19(18)	49	18(19)	5
Minimum A and C	5	29(30)	27	30(29)	9
Maximum E and C	5	18(19)	49	19(18)	9
Minimum E and C	9	30(29)	27	29(30)	5

MAXIMUM AND MINIMUM B AND C, OR D AND C SIMULTANEOUSLY (7.243)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum B and C	5	29	46	15	5
Minimum B and C	9	19	30	33	9
Maximum D and C	5	15	46	29	5
Minimum D and C	9	33	30	19	9

MAXIMUM AND MINIMUM A AND B, OR A AND D, OR E AND D, OR E AND B SIMULTANEOUSLY (6.793)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum A and B	10	33	32	19	6
Minimum A and B	4	15	44	29	8
Maximum A and D	10	19	32	33	6
Minimum A and D	4	29	44	15	8
Maximum E and D	6	19	32	33	10
Minimum E and D	8	29	44	15	4
Maximum E and B	6	33	32	19	10
Minimum E and B	8	15	44	29	4

MAXIMUM AND MINIMUM B AND D SIMULTANEOUSLY (6.816)

	A	B	C	D	E
Theoretical	7	24	38	24	7
Maximum B and D	5	31(30)	29	30(31)	5
Minimum B and D	9	17(18)	47	18(17)	9

GROUP II

N = 200 P = .1 Chi Square < 7.779

Maximum and Minimum A or E (7.743)

	A	B	C	D	E
Theoretical	14	48	76	48	14
per cent	7	24	38	24	7
Maximum A	24	46(45)	71	45(46)	14
per cent	12	23	35.5	22.5	7
Minimum A	4	50(51)	81	51(50)	14
per cent	2	25	40.5	25.5	7
Maximum E	14	45(46)	71	46(45)	24
per cent	7	22.5	35.5	23	12
Minimum E	14	51(50)	81	50(51)	4
per cent	7	25.5	40.5	25	2

Maximum and Minimum B or D (7.053)

	A	B	C	D	E
Theoretical	14	48	76	48	14
per cent	7	24	38	24	7
Maximum B	12(13)	64	68	43	13(12)
per cent	6	32	34	21.5	6.5
Minimum B	15(16)	32	84	53	16(15)
per cent	7.5	16	42	26.5	8
Maximum D	13(12)	43	68	64	12(13)
per cent	6.5	21.5	34	32	6
Minimum D	15(16)	53	84	32	16(15)
per cent	7.5	26.5	42	16	8

Maximum and Minimum C (7.676)

	A	B	C	D	E
Theoretical	14	48	76	48	14
per cent	7	24	38	24	7
Maximum C	12	40(41)	95	41(40)	12
per cent	6	20	47.5	20.5	6
Minimum C	16	56(55)	57	55(56)	16
per cent	8	28	28.5	27.5	8

The higher degree of conformity for the larger group of 200 indicates the effect of size. With very large groups, we would get much closer limiting distributions.

The rather large deviations in the foregoing tables are to be expected on a mere chance basis in the absence of other factors. Selective grouping would include other more fundamental changes. Also, the grading must be relative; external minimum standards or similar criteria are not covered.

These tables not only offer specific examples of limiting distributions for letter grade concentrations, but taken as a whole they present an overall picture of the possible variations.

Similar tables are obtainable for any Chi Square probability or for any size group by these same methods, thus supplementing the mere single Chi Square checks we could obtain on experienced distributions. In this way we can get an overall picture of the limiting distributions in advance, instead of mere affirmation or denial of the possibility of conformity to some theoretical distribution using some single experienced distribution.

THE CURRENT FREIGHT RATE DISPUTE IN THE SOUTH

William H. Joubert
University of Florida

From the beginning of railway transportation in the United States, freight rates have been a matter of serious controversy within the southern railway territory. The basic issues of this conflict are outlined in the present paper, with the object of clarifying the question and helping to eliminate the misunderstandings that surround it—misunderstandings such as usually exist when highly technical matters become public and therefore political issues.

For purposes of making railway freight rates the United States has been divided into five territories: northern, southern, western trunk line, southwestern and mountain-Pacific. The northern and southern territories lie east of the Mississippi River; the other three lie west of the river. The railroads have classified all articles of freight into three great "classifications." The *official* classification applies to the northern territory, the *southern* to southern territory, and the *western* to western trunk line, mountain-Pacific and southwestern territories.

Rates on freight classes lower than first class are expressed in percentages of the first class rate; all class rates are therefore very closely interrelated. In the southern classification, for example, 15,994 freight items are listed and assigned to 12 classes; for each of these 12 classes rates have been prescribed for all possible distances. In each of the five freight rate territories a different level of class rates exists, northern or official territory having the lowest rates. The other territories have class rates higher than those of northern territory by the following percentages: southern territory, 39%; western trunk line territory, 47%; mountain-Pacific, 71%; southwestern territory, 75%.

It is essential to note that class rates are distinct from commodity rates. When the railroads voluntarily or by order of the Interstate Commerce Commission give an item special treatment in the form of a rate lower than its class rate, the result is called a *commodity rate.* Most of the railway freight tonnage of the United States is moved on commodity rates. In fact, class rated traffic accounts for less than 25% of the freight revenue of southern railroads. This is explained by the fact that important agricultural and raw material commodities like cotton, tobacco, vegetables, citrus fruits, lumber, coal, iron ore, petroleum, and the leading manufactured products of the South, such as textiles, tobacco products and furniture, move in large volume and have been granted relatively low commodity rates.

For purposes of comparison and criticism, however, *class rates* and not commodity rates are the most reliable and accurate measure of rate relationships between the different rate territories. This conclusion is supported by the following facts: (1) the number of different freight items shipped under class rates is far greater than the number shipped under commodity rates; (2) since 1928 many commodity rates have been related to first class rates by percentages or parallel classification columns, and are, in reality, class rates; (3) in the South many finished manufactures, as contrasted with raw materials and semi-manufactured articles, are shipped on high class rates; (4) industries not yet established but contemplating location in the South are often discouraged from doing so by the high class rates upon which their products would have to move during the organizational stage.

Under the impact of the first world war the defects of the southern class rate structure were glaringly revealed. The railroads, by themselves and in cooperation with the shippers, made many efforts at revision, but were unable to construct a workable plan. Following these failures, in February, 1922, the Interstate Commerce Commission, armed with broadened powers, instituted a study of the entire southern class rate structure. After deliberating six years the Commission finally established three major systems of class rates to apply to southern territory: (1) a maximum distance scale of intraterritorial class rates to apply between points wholly within southern territory (the region east of the Mississippi River and south of the Ohio and Potomac rivers, but excluding most of Virginia; (2) a schedule of all-rail, water-rail and rail-water rates to apply between rate groups in that part of the northern territory lying east of the Mississippi River and rate groups in southern territory; and (3) scales of maximum interterritorial class rates, lower than the southern intraterritorial maximum scale, to apply on shipments of class items between the western part of the northern territory and the South.

A special adjustment was made in the intraterritorial rates to and from points in the South near northern territory, in order not to discriminate against southern shippers located close enough to the boundary to compete with shippers in northern territory. Also, the Florida Peninsula received separate and special treatment in the form of a mileage scale of arbitrary rates, (known as "*arbitraries*"), to be added to the regular southern class scale on interstate shipments to and from points in Florida. South of the line of the Seaboard from Jacksonville to River Junction, the class rate maximum was made approximately 15% higher than in the remainder of southern territory. For example, if an interstate shipment of first class freight is hauled 100 miles in southern territory other than the Florida Peninsula the rate is 79 cents per 100 pounds. However, if the identical shipment moves 100 miles, fifty miles of which are in Georgia and fifty miles in Florida, the rate is 79 cents plus an "arbitrary" of 9 cents, or 88 cents. Similar discrimination applies against Florida on all interstate shipments of freight moving on class rates except those to and from the East (where group rate adjustments have been made).

The maximum rates established as a result of the southern class rate investigation went into effect on January 15, 1928. The only important modification since made was a realignment of class rates between points in the North and borderline points in Carolina, Kentucky and Tennessee, made in 1935 and 1936.

The positive benefits of the southern class rate investigation of the nineteen-twenties cannot be denied. Numerous long overdue improvements in the rate fabric of the South were effected. On the other hand, serious causes for complaint and protest continued to exist. Although constructive changes had been made, the basic structure of rates in, and to and from, the South remained the same as before; the general level within the South was still much higher than in northern territory, and interterritorial class rates between the South and the North remained higher, mile for mile, than rates within the North. Because of coastwise water competition, rates from the eastern part of northern territory to the South were and have continued considerably lower, mile for mile, than rates from the western part of northern territory to the South. This was true in spite of the fact that by 1920 the southern railroads owned or completely controlled all of the steamship lines plying between the eastern and southern ports. Communities in Kentucky and the Carolinas continued to enjoy considerably lower rates per mile than the rest of the South on class shipments to and from northern territory. This so-called borderline adjustment is still the source of much dissatisfaction.

The system of "arbitraries" set up to apply on class rates to and from Florida, though much more reasonable and just than the previous combinations of local and specific rates on Jacksonville which the "arbitraries" replaced, is nevertheless based upon the same principle and theory as those combinations. In establishing these "arbitraries" the Commission failed to recognize that the population and the economy of the State have shifted southward into the peninsula, and that Florida is now the origin and destination of a large volume of high class freight tonnage. Many other justifiable criticisms can be brought against the Commission for its failure to make material changes in the southern class rate level and in the relationship of southern to northern rates.

During the late twenties and early thirties the Interstate Commerce Commission also investigated class rates in southwestern, western trunk line, and northern territory, and in the Far West. Scales of maximum intra- and interterritorial class rates were adopted for each territory, but in no case were the traditional relationships disturbed. In every revision the Commission adhered to the same general principles that guided it in the southern class rate investigation. Outworn systems and practices were discarded, but no fundamental changes were made in the existing rate levels or in the relationships between them.

Since 1928, when the revised rates went into effect, southern shippers have expressed growing dissatisfaction with the southern class rate structure. The South's rate problem may be dissected into three component parts: (1) class rates between points in the South are approximately 39% higher than class rates between points in official territory; (2) for equal distances class rates from the South to points in northern territory are approximately 20% higher than those wholly within the North; (3) in many instances class rates from northern territory to points in the South are considerably less, mile for mile, than those wholly within the South.

In 1937 the general opposition of the South to the existing freight rate structure was summarized in a brilliant report prepared by J. H. Alldredge of the Tennessee Valley Authority. On July 25, 1938, the National Emergency Council issued its now famous "Report on Economic Conditions in the South" which contained a brief (although erroneous and misleading) summary of the Alldredge document. The propaganda purposes of that report were nevertheless successfully accomplished, since it brought about nationwide discussion of the South's freight rate problem.

Another important page in the recent history of southern freight rates was the successful effort of the Southern Governors' Conference to persuade the Interstate Commerce Commission to reduce the rates from the South to the North on fourteen commodities to the same level, mile for mile, as rates within the northern territory. In a 5 to 4 decision on November 22, 1939, the Commission ordered material reductions in the interterritorial rates on these items, on the ground that the existing rates were extortionately high, unduly prejudicial to southern shippers and violative of section 15(a)2 of the Interstate Commerce Act, which requires the railroads not to set rates that impede the flow of traffic. In many respects the findings of the majority in this case were unique because they departed from the traditional interpretations of the Commission. On the other hand the decision resulted in readjustment of rates on only a few relatively unimportant commodities. It is doubtful if this action can be taken as indicative of the nature of the changes the Commission may ultimately make in the relative levels of territorial class rates throughout the nation.

The result of the Alldredge report, the report on economic conditions in the South, and the Southern Governors' case, was to convert the freight rate problem of the South into a political issue. In January, 1939, Congress began consideration of seven bills to readjust southern freight rates. Each of the bills has one or the other of two possible objectives: (1) to establish a mandatory and rigid *destination* principle of rate making or (2) to grant the Interstate Commerce Commission power to *eliminate freight rate discrimination* between regions, districts and territories. The destination principle would make rates from one territory to another no higher, mile for mile, than rates wholly within the territory to which the shipments were destined. As the debate proceeded the destination rule lost favor because of three main defects: (1) it would have necessitated different rates on freight moving in opposite directions over the same route—an inconsistency the Interstate Commerce Commission tried to avoid; (2) it was too inflexible; (3) it would have upset many rates with which both carriers and shippers were satisfied. Finally, the Transportation Act of 1940 was passed, containing a clause strengthening the hand of the Commission over regional rate discrimination. Specifically, section 3 of the Interstate Commerce Act was amended by the addition of the words "region," "district" and "territory" to the persons, things, and localities against which it had long been illegal to show undue or unreasonable prejudice or preference in making freight rates.

Neither the Alldredge report of 1937, nor the report on economic conditions in the South in 1938, nor the decision of the Commission in the Southern Governors' case of 1939, nor the Transportation Act of 1940 is the most significant recent development in the long struggle over freight rates in the South. Closely related to these events, and resulting largely from them, was the announcement by the Interstate Commerce Commission on July 29, 1939, that it was undertaking a general investigation of all class rates in the four freight rate territories lying east of the Rocky Mountains. This is not only the most important development in the present rate dispute, but also one of the most far-reaching steps ever taken by the Commission. Strengthened by the Transportation Act of 1940, the Commission *may* for the first time order a realignment of all class rates in the nation.

The outcome of this investigation cannot yet be predicted, but the arguments and evidence that have been and will be presented by the various groups and interests can be analyzed briefly. The shippers of the Southern, Southwestern and western trunk line territories want an equality of class rates with northern territory. The southern railroads, the northern railroads and northern shippers strongly oppose any fundamental change in the existing relationship. Also opposed are many southern producers of raw materials such as coal, iron ore, lumber, and crude manufactures. These producers already enjoy low commodity rates, and fear that any change in class rates may destroy this advantage.

The major arguments in favor of a modification are as follows. (1) Recent studies by the statistical staff of the Interstate Commerce Commission show that the cost of railway transportation in the South and Southwest is considerably lower than in the northern territory. This is especially true for hauls in boxcar loads, which is the most common method of shipping class freight. (2) A majority of the Interstate Commerce Commission has already held that the existing class rate maxima for the various rate territories are no longer a just measure of what class rates ought to be. (3) The present territorial boundaries, defined before 1900, are now illogical and should be abolished or radically readjusted. (4) A large body of evidence shows that valuable and highly refined manufactured products are particularly burdened and prejudiced by the present class rates. Recent studies made by the Tennessee Valley Authority reveal that the nearer a product comes to the final stage of production, the greater is the disadvantage in rates against the southern manufacturer. For example, rates on raw cotton from the South to the North are the same, mile for mile, as those within official territory. On bleached cotton fabrics the South to North rate is 11% higher than the rate wholly within northern territory; and on oil-cloth, a more highly processed cotton product, the disparity is 54%. Similar disparities exist on commodities made from cottonseed oil, pig iron, asphalt, ceramic clay, sulphur, lead and many others. (5) Farmers and other small raw material producers of the southern, southwestern, and western trunk line territories are persuaded that if manufacturing moves from northern territory into these regions, transportation costs from farm, forest and mine to the factory will be less, and hence the extractive industries will receive a larger share of the ultimate price. According to orthodox economic theory, reduced transportation costs do not result in larger incomes to competitive shippers, but in the case at hand the farmers would probably benefit.

The arguments presented by the northern manufacturers against revision of the present class structure are the same as those they have presented in favor of every tariff law from the "tariff of abominations" of 1832 to the Smoot-Hawley tariff of 1930. This group makes the following claims: (1) reduced transportation costs from the South to the North will cause a vast migration of industry, (2) the low wage industries in the South will destroy the wage level of the North, (3) the northern market belongs to northern producers, and (4) high freight rates have not hampered industrialization in the South.

The first three of these four arguments are based upon selfishness and fear. In determining fair rates the Interstate Commerce Commission is supposed to consider only those factors bearing upon transportation conditions. It is regrettable that sectional prejudices must be heard. As to the growth of southern industry, it is clear that in spite of remarkable progress in some fields, such as textiles, the South, for all its wealth of human and material resources, is still a poverty-ridden economic region.

The northern railroads oppose any change in existing class rate relationships on the ground that past approval by the Interstate Commerce Commission of the existing class rate structure attests to the reasonableness of those rates. An important but little publicized objection of these roads to elimination of the class rate disparities is that if the South manufactures its finished products from raw materials grown or extracted in the southern states, the northern carriers will neither share in the profitable long hauls of southern raw materials to factories in northern territory, nor enjoy the even more lucrative class rate traffic from the North to the South.

Although the railroads of the South sided with the southern governors in the Southern Governors' case, they have switched their position in the general investigation, and now express opposition to any change whatever in the present class rate relationships. As witnesses in the Southern Governors' case, the southern railroads were willing to cooperate in obtaining lower rates from the South to the North on a few relatively unimportant commodities because the northern railroads usually refuse to establish joint rates with the southern roads on manufactured products from the South to the North. In the general investigation the southern governors seek a lower scale of rates on all class traffic within and to and from the South. The southern railroads strongly oppose these reductions because of the fear of losses in revenue. These lines are entirely sympathetic with the northern railroads, and are exerting every power at their command to defeat the agitation for revising the existing rate structure. They have several arguments to support their case: (1) the revenue per mile of line operated is much less in the South than in northern territory, and lower rates would increase this disadvantage; (2) in distributing the transportation burden the southern railroads have to charge high rates on class traffic to offset the low commodity rates granted southern shippers; (3) since the Civil War the southern railroads have followed a traditional policy of granting low commodity rates on some southern manufactured goods in order to encourage industrialization in the South.

Judging from previous decisions of the Interstate Commerce Commission, and assuming no sharp break with past practice, one can confidently predict that the Commission will give no consideration or weight to most of these arguments. If the evidence convinces the Commission that costs of railway operation are less in the South than in the North, the cost argument will receive great weight. But even that evidence will not be conclusive if changes in rates would jeopardize railway revenue.

As has been said, it is too early to anticipate the outcome of the general investigation. The Commission may adopt a do-nothing attitude and eventually dismiss the case; or it may go so far as to eliminate the five freight rate territories and establish a maximum scale of class rates and a single uniform classification to apply throughout the United States. These are the extreme negative and positive possibilities. The decision will probably fall somewhere in between. The problem is very complex. An increase in the class rate level of northern territory might cause a great shift of class traffic to the truck and water lines and a relocation of the nation's industry. On the other hand a lowering of class rates in the high rated territories might bankrupt the railroads. This would be remotely possible if no immediate increase in the volume of traffic followed these reductions and if no readjustments were made in the division of joint rates between the northern and southern railroads. Also, lower class rates in the South might necessitate increases in rates on many commodities now enjoying low commodity rates.

One possible outcome is a modification of the present rate territories. An outstanding member of the Interstate Commerce Commission, the late Mr. Joseph B. Eastman, who handed down a dissent from the majority decision in the Southern Governors' case and who generally opposed the recent agitation by the South and West for lower rates, recognized the inequality of the present territorial boundaries. In 1934 he referred to the territory boundary lines as "Chinese Walls" and complained that the existence of different freight rate territories tended to provincialize the railroads and to discourage national unity of action.

In the present conflict the southern shippers, acting through the Southern Governors' Conference and the Tennessee Valley Authority, have won every preliminary skirmish and every major battle. The preponderance of evidence tends to substantiate their arguments. Nevertheless, anticipation of a decision favorable to the South in the present controversy must be qualified by consideration of the past actions, attitude and traditional reasoning of the Interstate Commerce Commission. On the basis of its historical record southern shippers direct six major charges against that body. (1) The Commission neglects its administrative functions as a quasi-judicial body by over-emphasizing its judicial functions. (2) The Commission adheres too rigidly to precedent and tradition, long after economic developments have overthrown the necessity and justification for relying upon historical evidence. For example, although the center of Florida's population and economic activity has shifted southward into the peninsula, the present class rate adjustment is based upon a time when the economy of the state was clustered around Jacksonville. (3) In more than twenty decisions the Commission has stated that transportation conditions are more favorable, therefore, costs of transportation are less in northern territory than in southern territory. Until recently, however, neither the Commission itself, nor the railroads, nor the shippers have made a reliable study of comparative transportation costs in the various rate territories. (4) In setting up a maximum scale of class rates the Commission has placed mistaken emphasis upon high traffic density in northern as compared with southern territory. It is true that much of the capacity of a railroad is unused, and many of the costs like interest, taxes, rentals and depreciation are constant. Therefore, the more traffic hauled, the less the per unit cost and the lower the rate. Accepting this density argument as conclusive, the Commission sanctions a low class rate level in the North and a high rate level in the South. By doing so it overlooks two vital items: (a) a high level of class rates discourages the growth of traffic density in the South; (b) greater density justifies reduced rates only up to a certain point, beyond which point inefficiencies appear, costs increase and higher rates may be justified; evidence seems to show that northern railroads have reached this stage of increasing costs. (5) Probably because of fear of reversal by the federal courts, the Commission has tended to argue that it cannot exercise powers which Congress clearly intended it to possess, and the vigorous application of which would relieve the South of many onerous freight rate discriminations. (6)

The Interstate Commerce Commission, either intentionally or unintentionally, arrives at decisions which complicate the problems of southern shippers. The horizontal percentage rate increases in 1938 and 1942 support this contention. Percentage increases always militate against high rated territory. For example, if the rate in southern territory is $1.39 and that in northern territory is $1.00, the difference is 39 cents. If the rates are increased 10% the southern rate becomes $1.53 and the official rate $1.10. The difference in the rates is increased from 39 cents to 43 cents, or an increased disadvantage of 4 cents per 100 pounds for the southern shipper. This difference of 4 cents per 100 pounds, applied to hundreds of millions of pounds of traffic, adds up to a tremendous burden on the southern economy.

To the extent that the Interstate Commerce Commission has modified the policies that gave rise to these six criticisms, the outlook for the southern shippers in the general investigation is bright. The favorable decisions in the borderline cases of 1935 and in the Southern Governors' case, and the refusal of the Commission thus far to dismiss the general investigation because of the war emergency are very favorable signs. Whatever the outcome of the general investigation, the agricultural, manufacturing and commercial interests of the southern, southwestern and western trunk line territories will continue their fight against the existing class rate disparities until some concessions are wrung from the Interstate Commerce Commission, or the railroads, or Congress.

THE OCCURRENCE AND DISTRIBUTION OF ALGAE IN SOILS[1]

F. B. SMITH
University of Florida

Since the algae are able to synthesize organic matter and some species may fix atmospheric nitrogen, the economic significance of these organisms is, at least by implication, considerable. The answer to the question of their practical importance in soils depends to a large extent upon the frequency of their occurrence and their distribution in soils as well as their ability to fix carbon and nitrogen. According to Singh[2] certain Indian soils were increased in organic matter from 1-2% to 4-6% by the growth of some of the blue-green algae. The ability of certain of the blue-green algae to fix nitrogen is unquestioned. Although a great deal of work has been done to show the existence of an algal flora of soils, as pointed out before,[3] very little of this work has been done on the soil type basis. The purpose of the work reported here was to make further studies on the occurrence and distribution of algae in soils.

Methods of Procedure

The soils used in this study were Norfolk fine sand, Orangeburg fine sandy loam, Bradenton fine sandy loam and Muskingum stony loam. With reference to the great soil groups, the first two types belong in the Red and Yellow podsolic group and the Muskingum stony loam is a member of the Gray Brown podsolic group. The Red and Yellow soils were developed in central and northern Florida, and the Gray Brown podsolic was developed in Giles County, Virginia, in the vicinity of Mountain Lake. The Norfolk fine sand was sampled June 6, 1942, about 3 miles east of Gainesville, Florida, on the Hawthorne road. The profile was exposed by digging a trench about 2 feet wide, 3 feet long and 3 feet deep. Samples of soil were taken aseptically from this vertical cut at 0-1 inch, 4-5 inch, 8-9 inch, 12-13 inch, 24-

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[2] Singh, R. N. The Role of Blue Green Algae in the Reclamation of "USAR" Land. *Proc. Indian Sci. Congr.*, 28: paper No. 4 (1941). (Abs. in Biol. Abs. 16, No. 7, 1942).

[3] Smith, F. B. and H. R. Ellis, Preliminary Report on the Algal Flora of Some Florida Soils. *Proc. Fla. Acad. Sci.*, Vol. 6 (1943), pp. 59-65.

[1] Report of work done under a research fellowship granted by the Mountain Lake Biological Station, Mountain Lake, Virginia, 1942. The author takes this occasion to express his appreciation of the aid and to acknowledge the assistance of Director Ivey F. Lewis and Dr. E. C. Cocke in the identification of some of the species.

25 and 30-31 inch depths. The other soil profiles were sampled in a similar manner, except that samples were not taken at all depths named above in the other soil types. The Orangeburg fine sandy loam was obtained in the vicinity of Quincy, Florida, and was sampled June 16, 1942. The Bradenton fine sandy loam was taken in Manatee County, Florida, June 26, 1942. The Muskingum soil was sampled August 7, 1942.

Typical profiles of the above named soil types are described as follows:

1. Norfolk Fine Sand.[4]

A_1	0-3″	Gray to yellowish—gray fine sand.
A_2	3-30″	plus—yellow sands, underlaid usually at 6 to 8 feet below the surface with friable sandy clay.

2. Orangeburg Fine Sandy Loam.

A_1	0-4″	brownish-gray to grayish-brown fine sandy loam.
A_2	4-16″	yellow to brownish-yellow sandy loam.
B	16-54″	bright red friable sandy clay.
C	54″	plus—red friable sandy clay mottled with yellow and gray.

3. Bradenton Fine Sandy Loam.

I.	0-4″	gray loose fine sand.
II.	4-18″	light gray or almost white incoherent fine sand.
III.	18-26″	gray, brown and yellow mottled compact fine sandy clay loam.
IV.	26-36″	plus—grayish white marl.

4. Muskingum Stony Loam.

A_0		thin layer of loose forest litter.
A_1	0-2″	dark grayish brown loam and small rock fragments.
A_2	2-8″	grayish yellow heavy loam, friable, rock fragments.
B	8-18″	light grayish-yellow silty clay and rock fragments.
C	18″	plus—bedrock sandstone and shale.

The soils were brought into the laboratory thoroughly mixed and 10 grams of the moist soil placed in 50 cc. of sterile Beijernick's solution in 250 cc. Erlenmeyer flacks. The cultures were placed in a window where the sun could strike them a part of the day. Cultures of the Norfolk fine sand were inoculated June 6 and growth appeared June 17. Cultures of the Orangeburg fine sandy loam were inoculated June 17 and growth appeared June 27. Cultures inoculated with the

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[4] Henderson, J. R. Soils of Florida. *Bull. Florida Agric. Exp. Station,* No. 334 (1939).

Bradenton fine sandy loam June 27 showed growth July 4. On account of the relatively low temperatures prevailing in the laboratory at Mountain Lake (15-25°C.) it was found necessary to provide artificial light and heat. Two large battery jars were each fitted with covers to which 200 watt Mazda lamps were attached. This arrangement provided a temperature of 40-45°C. inside the battery jar and a light intensity of 200 foot candles. This temperature proved to be too high for the growth of the soil algae. The cultures were placed on the table in front of a window outside the battery jars and a cardboard shield placed around three sides of the battery jars opposite the cultures. This arrangement provided a minimum light intensity of 200 foot candles and a temperature of 25-30°C. Growth appeared in 14-18 days under these conditions. Water mounts made from a loopful of the culture served for microscopical examination. The forms found are recorded in Table I.

List of Species

Norfolk fine sand.

Numerous pear-shaped cells in young cultures of soil from the 0-1 inch depth, 20x50 to 40x60 microns in size, becoming ovoid after a few weeks were identified as *Kentrosphaera* sp. Attempts to isolate this organism for pure culture study failed but this work is being continued. The most numerous alga in this soil was *Chlorococcum humicola* (Nag.) Rab. Another common form found in the surface inch of this soil was *Stichococcus subtilis* (Kütz.) Klecker. *Phormidium autumnale* (Ag). Gom. and *Phormidium inundatum* Kütz. were abundant in older cultures from the surface sample of this soil. *Protococcus* sp. and *Chlorella* sp. were fairly numerous in the surface sample. *Mesotaenium* sp. and *Navicula* sp. were encountered less frequently than other forms in the surface sample of the Norfolk fine sand. *Chlorococcum humicola* was present abundantly in all samples of Norfolk fine sand examined to the 24-25 inch depth. *Stichococcus* sp. was found only in the 30-31 inch depth of this soil. This organism was not found in any other soil examined.

Orangeburg fine sandy loam.

Chlorococcum humicola was the most abundant form in the Orangeburg fine sandy loam. This organism was present in the surface inch and the 4-5 inch samples. Numerous cells of *Protococcus* sp. and *Tetraedon* sp. were found in the surface inch but not at greater depths. Numerous filaments of *Stichococcus subtilis* developed in the cultures from both the 0-1 inch and the 4-5 inch samples of soil. An occasional filament of *Phormidium* sp. was found in old cultures of the 0-1 inch sample.

Bradenton fine sandy loam.

Chlorococcum humicola was found in all samples of the Bradenton fine sandy loam from the surface to the 9 inch depth. The *Chlorococcum* in this soil differed from the *Chlorococcum* in the Orangeburg fine sandy loam in that cells with button-like swellings never occurred and from the *Chlorococcum* in the Norfolk fine sand in the greater variation in the size of cells. Unialgal cultures of this organism from these soils have been prepared for further study. *Chlorella* sp. was numerous in the surface and subsurface samples of this soil. The cells of *Kentrosphaera* sp. were 25 to 40 microns in diameter and were spherical to pyriform in shape, differing considerably in appearance from the *Kentrosphaera* sp. found in the Norfolk fine sand.

Muskingum stony loam.

Chlorococcum humicola and *Stichococcus subtilis* developed abundantly in the culture inoculated with the surface sample, 0-5 inch depth, of Muskingum stony loam. The culture was inoculated August 7 and examined August 26. Possibly other forms would have developed in the culture later. A sample of the soil was taken for further study.

Discussion and Summary

The methods employed in this study were adaptations of the bacteriological technique and a modification of the methods usually employed in a study of aquatic forms. The procedure followed was not entirely satisfactory because of the different rates of growth of the different genera, and the succession of forms made several examinations necessary. Also because some forms soon deteriorate and if the culture is not examined at the proper time such forms may not be found. Furthermore, it is difficult to determine a given species in a mixture of other species. In many cases unialgal cultures may be an aid in species differentiation but efforts in this direction have not been uniformly successful. Also the other difficulties enumerated often exist in unialgal cultures as well as in mixed cultures. However, in spite of these difficulties considerable information concerning the occurrence and distribution of algae in soils was gained. The data in Table 1 show that *Chlorococcum humicola* was found in the surface inch of all soils examined. This species was found in all samples of Norfolk fine sand to a depth of 25 inches but not below the 8-9 inch depth in the Bradenton fine sandy loam and the 4-5 inch depth of the Orangeburg fine sandy loam. *Stichococcus* sp. was widely distributed in the soils examined and *Protococcus* sp. was found in the surface inch of Norfolk fine sand and Orangeburg fine sandy loam. Only one genus of the Myxophyceae, *Phormidium*, was found in these soils, the surface of Norfolk fine sand and the surface of Orangeburg fine sandy loam. Diatoms were encountered in only the surface inch of Norfolk fine sand.

While certain forms seem to be widely distributed in soils, the different soil types appeared to have a characteristic algal flora, or at least soil type differences were apparent. However, there was no apparent relationship between soil reaction (Table 2) and the occurrence of the forms found in these soils.

Representative coastal plain soils from south, central and north Florida and from the Appalachian Highlands in southwestern Virginia were used in this study. *Chloroccum humicola* was found in the surface of all soils examined. This organism was also found distributed throughout the profile of the Norfolk fine sand to a depth of 25 inches.

TABLE I

Species of Algae in Four Soil Types

Depth	Norfolk fine sand	Orangeburg fine sandy loam	Bradenton fine sandy loam	Muskingum stony loam
0- 1 in.	1	1	1	1
	2	2	8	6
	3	6	7	
	4	5		
	5	11		
	6			
	7			
	8			
	9			
	10			
4- 5 in.	1	1	1	1
		6	7	6
8- 9 in.	1	0	1	**
12-13 in.	1	0	0	**
24-25 in.	1	**	**	**
30-31 in.	12	**	**	**

0 No organism found
1 *Chlorococcum humicola* (Nag.) Rab.
2 *Protococcus* sp.
3 *Phormidium autumnale* (Ag.) Gom.
4 *Phormidium inundatum* Kütz.
5 *Phormidium* sp.
6 *Stichococcus subtilis* (Kütz.) Klecker.
7 *Kentrosphaera* sp.
8 *Chlorella* sp.
9 *Mesotaenium* sp.
10 *Navicula* sp.
11 *Tetraedron* sp.
12 *Stichococcus* sp.
** Not Sampled.

TABLE II
pH of Soils

Soil Type	Depth of Sample (inches)	pH
Norfolk fine sand	0-1	5.36
	4-5	5.56
	8-9	5.45
	12-13	5.85
	24-25	6.19
	30-31	6.02
Orangeburg fine sandy loam	0-1	5.30
	4-5	5.30
	12-13	5.28
	18-19	5.20
Bradenton fine sandy loam	0-1	4.70
	4-5	4.22
	12-13	4.75
	18-19	5.08
Muskingum stony loam	0-5	4.25

SOME PROPERTIES OF ROSIN

J. Erskine Hawkins

University of Florida, Gainesville, Florida

Until a few years ago color was the principal criterion in determining the value of a given sample of rosin, regardless of the purpose for which it was to be used. More recently, greater emphasis has been placed on the physical and chemical properties of the rosin in deciding its suitability for any particular use.

When sufficient information becomes available it may be that one or two characteristics can be correlated satisfactorily with other properties so that these other properties can be estimated without resorting to their direct determinations. As the interrelations of the constituents of rosin are unfolded, the optical rotation may become a basis for this correlation.

In addition, it is of interest to know how successfully the method used by Georgi,[1] in determining the specific rotation of some pure rosin acids from rotations of their solutions, can be applied to rosin.

In view of the above, and inasmuch as commercial processes are carried out with rosin and not with pure acids, the present work was undertaken to determine the possibility of measuring the rotation of rosin solutions of various concentrations and estimating the specific rotation of the solid rosin from these data.

Some determinations of this nature have been made by Hawkins, Black and others. The purpose of the latter work was to complete a study of the conventional constants of gum turpentine and gum rosin of known origin, which had been undertaken by Black and coworkers.[2] The unpublished data of Hawkins, Black, and others involving the optical rotation showed some interesting relations which will be briefly indicated. They prepared solutions of rosin of various concentrations, using benzene and alcohol as solvents.

The specific rotation of the solutions was calculated by the equation

$$a]^{t}_{D} = \frac{a\ v}{g\ l} \qquad (1)$$

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[1] Georgi, E. A., "The Rosin Acids," *Journal of Chemical Education,* Vol. 10 (1933), p. 415.

[2] (a) Black, A. P. and Thronson, S. M., "Oleoresin from Individual Trees of Slash and Longleaf Pine," *Industrial and Engineering Chemistry,* Vol. 26 (1934), p. 66;

(b) Dustin, W. A., "Conventional Constants of Pine Gum Rosin of Known Origin," *Thesis,* University of Florida, 1935.

TABLE I
Rotations of Solid Rosins

Sample	Temp. °C	Length dom.	Obs. Rotation	Specific Rotation By Eq. 3	Specific Rotation By Eq. 4
A	38	0.588	19.9	33.9	
	33	.588	20.2	34.3	
	30	.632	21.9	34.7	
	30	.395	13.6	34.4	
	27.2	.632	22.1	35.0	
			Average Value:	34.4	32.3
B	32	0.150	4.45	29.7	
	32	.640	18.9	29.5	
	30	.885	26.5	29.9	
	30	.535	16.1	30.1	
	30	.640	19.1	29.8	
	30	.885	26.2	29.6	
	26	.535	16.3	30.5	
	26	.885	26.8	30.3	
	26	.640	19.3	30.2	
			Average Value:	30.0	28.2
C	32.2	0.705	21.3	30.2	
	30.5	.495	14.9	30.1	
	30	.705	21.2	30.1	
	29.8	.795	23.8	29.9	
	26	.495	15.1	30.5	
	26	.705	21.5	30.5	
	26	.795	23.7	29.8	
			Average Values	30.2	28.3
D	32	0.475	14.2	29.9	
	32	1.13	33.7	29.8	
	26	.475	14.5	30.5	
	26	1.13	33.7	29.8	
			Average Value:	30.0	28.2
E	28.5	1.39	56.6	40.7	
	28.5	1.40	56.9	40.6	
	28.5	.820	33.5	40.8	
	28.5	.530	21.7	41.0	
	28.4	.905	36.9	40.8	
	28.4	.440	17.9	40.7	
			Average Value:	40.8	38.3
F	28.7	.592	24.2	40.9	
	28.7	.585	24.0	41.0	
	28	1.24	50.3	40.6	
			Average Value:	40.8	38.3
G	28	.595	22.7	38.1	
	28	1.02	38.8	38.1	
	28	1.02	38.9	38.2	
			Average Value:	38.1	36.1

TABLE II

Part A

Average Results of 2 to 4 Readings on 1 to 3 Samples at Temperatures Between 26° and 31°C

Specific Rotations

% Rosin	5	10	20	30	40	50	60	70	100	100	100
Sample									Extrp.	Eq.3	Eq.4
B	41.8	41.2	39.6	38.8	37.5	36.5	35.5	33.0	30.2	30.0	28.2
C	......	......	39.0	38.5	37.8	36.5	35.4	33.9	31.0	30.2	28.3
D	......	......	40.3	39.0	37.9	36.5	35.5	34.4	30.7	30.0	28.2

Part B

Complete Data on Samples on which Only One Series of Determinations Was Made

Sample A

% Rosin	5	10	20	30	40	50	60	70	100	100	100
									Extrp.	Eq.3	Eq.4
Temp. °C.	28.0	27.8	27.6	27.3	28.0	26.0	26.0	31.0	......	......	
Length, dcm.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	......	......	31.6
Obs. Rotation	2.19	4.35	8.50	12.6	16.5	20.4	24.3	27.1	......	......	
Spec. Rotation	49.7	48.8	47.0	45.5	44.6	42.2	41.3	39.2	35.0	34.4	32.3

Sample E

% Rosin	20	30	40	50	60	70	100	100	100
							Extrp.	Eq.3	Eq.4
Temp. °C.	27.5	28.0	27.5	28.0	28.0	29.2	......	......	28.5
Length, dcm.	2.0	2.0	2.0	1.0	1.0	1.0	......	......	
Obs. Rotation	18.7	28.1	37.1	22.0	27.5	31.5	......	......	
Spec. Rotation	51.8	50.7	49.4	47.9	46.9	45.1	41.3	40.8	38.3

Sample F

% Rosin	20	30	40	50	60	70	100	100	100
							Extrp.	Eq.3	Eq.4
Temp. °C.	28.6	28.8	28.0	28.6	28.8	29.0	......	......	28.5
Length, dcm.	2.0	2.0	2.0	1.0	1.0	1.0	......	......	
Obs. Rotation	19.1	28.5	37.8	23.5	27.7	31.5	......	......	
Spec. Rotation	52.7	51.5	50.3	49.0	47.2	45.2	41.4	40.8	38.3

Sample G

% Rosin	20	30	40	50	60	70	100	100	100
							Extrp.	Eq.3	Eq.4
Temp. °C.	30.0	30.0	29.0	29.8	29.8	29.8	......	......	28.0
Length, dcm.	2.0	2.0	2.0	1.0	1.0	1.0	......	......	
Obs. Rotation	18.1	27.1	36.0	22.2	26.5	30.3	......	......	
Spec. Rotation	50.0	49.1	47.8	46.1	45.2	43.4	39.4	38.1	36.1

in which a is the observed angle of rotation, g is the weight, in grams, of rosin, l is the length of polarimeter tube in decimeters, and v is the volume of solvent. This equation differs from the ordinary one but has been used by Aschan[3] in his studies.

Plots of specific rotation versus per cent of rosin by weight in the solution produced results indicated by the graphs in Figure 1. There appears to be no doubt that the specific rotation is affected by the concentration of the solution and by the solvent used. The tendency for the extrapolated curves, for the same sample of rosin in different solvents, to meet at 100% rosin is of no particular significance. This point corresponds to zero volume of solvent and should therefore be at 0° rotation in all cases.

Georgi[1] has presented the results of similar studies of solutions of pure abietic acid. For an example see Fig. 2. In calculating the values of the specific rotation he used the customary relation

$$a]_{D}^{t} = \frac{a\,w}{l\,g\,d} \qquad (2)$$

Where a = the observed rotation; w = the weight of solution; l = the length of the polarimeter tube in decimeters; g = the grams of acid dissolved in w grams of solution; d = the density of the solution. The extrapolation of his graphs to a point corresponding to 100% acid indicate that the curves meet at a common point, in this case —38°, which should be the specific rotation of the pure acid. This value checks reasonably well with the —35° obtained from measurements on the solid compound.

In preparing the sample of the solid acid Georgi fused the material. Since abietic acid is isomerized by heating, it is believed that this procedure changed the value of the rotation and therefore a close check should not be expected here.

In the present work fusion of the rosin was avoided. Samples of the solid were prepared either by chipping large pieces of rosin to the appropriate size and then smoothing the parallel surfaces with a hot flat iron, or by pouring the rosin into molds at the still and smoothing the surfaces as indicated. This latter procedure is recommended.

The molds were made from cardboard mailing tubes with a cork closing the lower end and were approximately 1 3/8 inches in diameter and 10 inches long. After cooling, the samples were broken into two unequal lengths and their ends, perpendicular to the long axis, smoothed on a hot flatiron. The optical rotation of each piece was determined and its length and temperature recorded. Following this, solutions varying from 5% to 70% rosin in benzene were made. In carrying out this last step, the rosin was weighed, after the surface layer had been removed, and immediately dissolved in the proper amount of solvent. This precaution reduces the possibility of having oxidized rosin acids in the solution. The optical rotation of each solution was read as soon as possible.

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[3] Aschan, O., *Naphtenverbindungen Terpen and Campherten* (Berlin: Walter De Gruyter and Co., 1929).

Benzene was used as the solvent. It was found that commercial benzene was just as satisfactory for the purpose as was a highly purified product. All measurements were made with a polarimeter reading directly to 0.01° and at temperatures between 26° and 31° C.

The calculation of the specific rotation of the solid was made according to the following equations:

$$a]_{\mathrm{D}} = \frac{a}{l} \qquad (3) \qquad \text{and} \qquad a]_{\mathrm{D}} = \frac{a}{l\ d} \qquad (4)$$

The value of d used was the density at the average temperature of the observations as listed in Table I. The calculated values of a are given in Table I. The values calculated by (3) agreed with the values obtained by the extrapolation of the data on the solutions better than the values calulated by equation (4).

The literature contains comparatively little information concerning the rotatory power of solids. The relations expressed by equations (3) and (4) have been applied to crystals and have been used in the calculations in this paper. On page 340 of his book, Lowry[4] states: "The rotatory power of a crystal is usually expressed as the rotation produced by 1 mm. thickness; the rotatory power of a solution may be expressed in comparable units by means of the function $[a]\ d/100$ where $[a]$ is the specific rotation and d the density of the solution; conversely the rotatory power of a crystal, per mm. can be expressed like that of a solution as $[a] = \frac{100\ a}{d}$."

The specific rotation of each solution was calculated by use of equation (2). Some data and results are included in Table 2 and are plotted in Fig. 3.

In a number of cases the reproducibility of the data, especially at concentrations below 30% rosin, was not satisfactory. In some cases the optical rotation of a given solution seemed to change continuously. On the other hand, many solutions were kept for months with no appreciable alteration in the rotation. No explanation for the lack of

---

[4] Lowry, T. M., *Optical Rotatory Power.* (London: Longmans, Green and Co., 1935).

TABLE III

Density of Solutions of Rosin in Benzene

% Rosin Temp. °C.	0	5	10	20	30	40	50	60	70
28	0.8703	.8786	.8898	.9043	.9215	.9399	.9599	.9790	.9978
33	0.8653	.8740	.8855	.9006	.9186	.9377	.9569	.9767	.9954
38	0.8603	.8700	.8809	.8957	.9133	.9323	.9525	.9717	.9912

TABLE IV

Density of Solid Rosin

Temp. °C Sample	27.2	33.0	38.0
1	1.0678	1.0653	1.0591
2	1.0670	1.0634	1.0611
3	1.0659	1.0626	....
4	1.0673	1.0638	1.0602
Average	1.0670	1.0638	1.0602

TABLE V

Apparent Specific Volume of Rosin in Benzene at 33°

% Rosin	5	10	20	30	40	50	60	70
Θ	1.146	0.9960	0.9755	0.9589	0.9497	0.9458	0.9437	0.9448

reproducibility is offered. However, in every case, data on solutions above 30% rosin could be reproduced sufficiently well so that extrapolation to 100% usually gave a value which checked the observed value of the solid within approximately 1°, when using equation 3.

Discussions of the solvent effects on rotation and the variation of specific rotation with concentration have been presented by T. M. Lowry[4] and more recently by Kauzmann, Walter and Eyring.[5]

Density Determination. The densities of the rosin solutions were determined, by using a Westphal balance, at 28.0, 33.0, and 38.0° ± 0.1°. These values could be readily reproduced to within 3 parts in the fourth place. Values of pure benzene checked within this limit with the values given in the International Critical Tables.[6] The data are given in Table III. The variation of density with concentration is not linear.

The densities of four solid rosin samples were determined at 27.2°, 33.0° and 38.0° ± 0.1°. The rosin samples were about 10 cm. long and 3.5 cm. in diameter. These were suspended by a thread in a thermostat for several days and then weighed in water at the same temperature and afterwards rapidly dried with a cloth and weighed

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[5] Kauzmann, W. J., Walter, J. E., and Eyring, H. "Theories of Optical Rotatory Power." *Chemical Reviews,* Vol. 26 (1940), p. 339.

[6] I. C. T., Vol. 3, pp. 29, 33. (New York: McGraw-Hill Book Company, 1928).

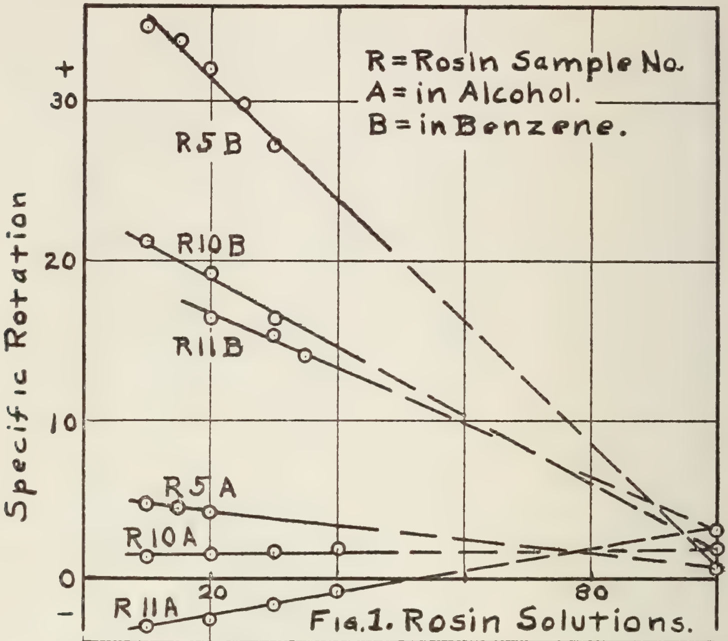

Fig.1. Rosin Solutions.

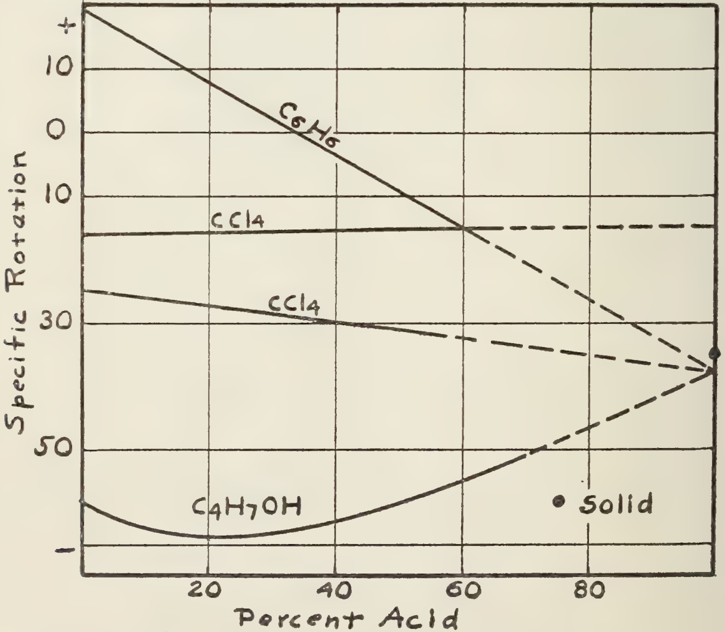

Fig.2. Abietic Acid Solutions

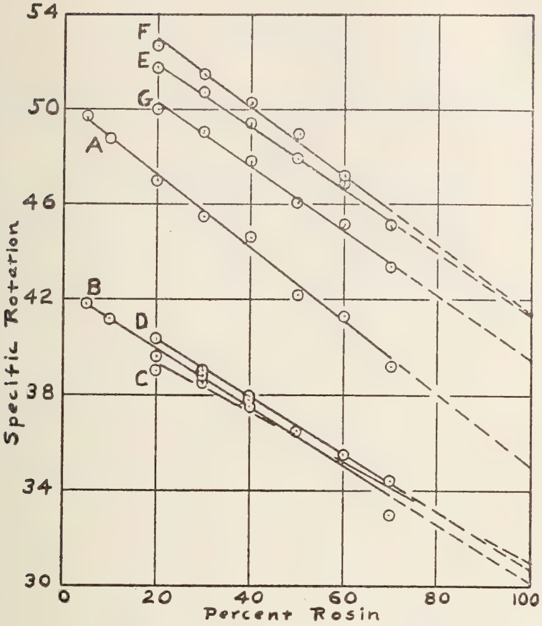

Fig. 3. Rotation Rosin in Benzene.

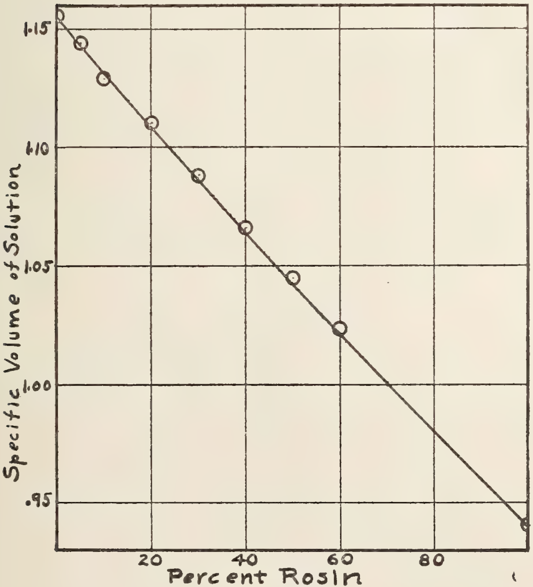

Fig. 4. Specific Vol. vs % Rosin-33°C.

in air. The results are given in Table IV. These values are believed to be no better than one in the third decimal place.

Apparent and Partial Specific Volumes. The apparent specific volume of rosin in benzene was calculated at 33.0° from the density data by the equation, $\Theta = \frac{v - w_1 v_1}{w_2}$ (5),

where v equals the volume of one gram of the solution, w_1 equals the weight of benzene in one gram of solution, v_1 equals the volume of one gram of benzene, and w_2 equals the weight of rosin in one gram of solution. These values are given in Table 5.

The partial specific volume of the rosin may be defined as the change in volume of the solution of a given concentration when one gram of rosin is added to the solution under such conditions that there is no appreciable change in the concentration of the solution. Mathematically it is the ratio

$$\left(\frac{dv}{dw_2}\right)_{comp.} \text{ and is designated by } \overline{v_2}.$$

One method of determining the value of the partial specific volume is to plot the specific volume of the solution against the percent rosin present at various concentrations. If a tangent to this curve is drawn at any concentration, then the intercept of the tangent at 100% rosin is the partial specific volume of rosin and the intercept at 0% rosin is the partial specific volume of benzene at the chosen concentration.

This plot is given in Fig. 4 and appears to be almost a straight line. This means that the partial specific volumes are practically the same at all concentrations and have a value of 1.0005 cc. for rosin and 1.1557 cc. for benzene.

The samples of rosin used in this investigation were supplied through the courtesy of Mr. E. Mize of Fairbanks, Florida.

SUMMARY

1. The estimation of the specific rotation of solid rosin can be made from measurements of the optical rotation of rosin solutions.
2. The densities of rosin and rosin solutions in benzene at 28°, 33°, and 38° C. have been determined.
3. The apparent and partial specific volume of rosin in benzene has been calculated at 33°.

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SECONDARY FOREST SUCCESSION IN THE TALLAHASSEE RED HILLS

HERMAN KURZ
Florida State College for Women

GEOLOGY AND SOILS

Characterizing the approximate northern half of Leon County, Florida, the Tallahassee red hills represent deeply weathered sandy limestone of the geological formation known as the Hawthorn.[1] Due to the combined results of surface erosion and underground solution of limestone resulting in subsidence of overlying materials, the hills are irregular and the valleys display some discontinuity and apparent lack of drainage system. Solution caverns divert surface streams underground. An abandoned channel thus becomes a dry valley above. The subterranean portion of the stream flows on only to rise elsewhere and to feed from below sinks, ponds, and lakes, or to reappear as a large spring in the lower elevation near the coast. Most of the isolated basins, blindly ending or apparently discontinuous streams, and unevenness of surface not directly attributable to surface erosion, are, according to Sellards,[2] caused by underground work of water. A topographic map by the same worker shows that, at the stations studied in the present work, the altitude ranges from about 100 feet above sea level near the valley or basin floors to about 230 feet on the hill tops or plateaus.[3] This range in elevation is sufficient to provide decided hills and slopes which, in most places, are mantled with the well drained loam soils so favorable for the various forests and other types of plant communities found in this region.

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[1] C. W. Cooke and Stuart Mossom, "Geology of Florida," *Florida Geological Survey, 20th Annual Report* (1929), p. 123.

[2] E. H. Sellards, "Geology between the Ocklocknee and Aucilla Rivers in Florida," *Florida Geological Survey, 9th Annual Report* (1917) pp. 92-101, 116-128.

[3] *Ibid.*, pp. 100-101 (map insert).

The vegetation appears like the heterogeneous patchwork of a crazy quilt: here is a field fallow with last year's corn stalks and rank with this season's weeds—mostly annuals; there lies a field of dog-fennel and broom-sedge; elsewhere a patch is characterized by dark green young short-leaf pines spaced in between the tufts of dog-fennel or clumps of broom-sedge; in one area is a dense growth of young pine trees, two to six inches or so in diameter and standing a hundred or more to a twenty-five foot radius; in another place will be similar but much larger pines with a liberal mixture of oaks, hickories, and an understory of dogwood, white with flowers in March. Hardwoods often running up to twenty inches in diameter and representing fifty or more species of trees and shrubs are punctuated with the dark glistening foliage of towering magnolias. In some situations, by way of variety, the magnolias will be mere saplings just arriving in this mixed assemblage of many hardwood species. Other sites will display solid or almost solid stands of mature magnolias.

An early soil map of Leon County by Wilder *et al*[4] designates the soils of the localities studied for the present paper as Orangeburg fine sandy loam, Norfolk fine sandy loam, or Orangeburg sand, the first being the one most often encountered and the third the rarest. According to a recent soil map[5] nearly all the stations studied lie within one of the areas designated as "Red and Yellow soils: Norfolk-Greenville Areas." Under that broad heading are listed thirteen types: "Norfolk, Ruston, Red Bay, Orangeburg, Marlboro, Tifton, Faceville, Carnegie, Magnolia, Gilead, Greenville, Cuthbert, and Susquehanna sandy loams." Within the area selected for this investigation the soils display noticeable variation in their proportions of sand, clay, and humus. I have, however, had no soil determination made, for it is very evident that factors such as fire, cutting, and grazing play a much more profound role in the local vegetational changes and forest development than do the individual differences of the related soils. The clayey subsoils derived from the Hawthorn formation are rich in oxidized or dehydrated iron compounds and appear as strikingly red banks along the roads and gullies; hence the term, Tallahassee red hills.

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[4] H. J. Wilder and others, "Soil Survey of Leon County, Florida," *U. S. Dept. of Agr., Bureau of Soils* (1906).

[5] "Generalized Soil Map of Florida," in: Henderson, J. R., "The Soils of Florida," *University of Florida Agr. Exp. Sta. Bull.*, No. 334 (1939), 67 pp., 5 figs., 2 maps in folder.

PREVIOUS WORK

In the pioneer study of succession in northern Florida, Gano[6] portrays the physiographic ecology of the entire and rather diversified area included in Leon County. Comprehensive and general in nature, this paper does not treat in detail the plant successions of the Tallahassee red hills. Twenty-five years have elapsed since the publication of Gano's groundwork, and the writer has therefore been encouraged to undertake the study of the secondary successions in the red hills.

ACKNOWLEDGEMENTS

Credit is due to William Dean Wilson, Draftsman, Florida Geological Survey, for the preparation of the schematic diagram of Plate 1. I must also acknowledge the aid of Edwin V. Komarek, Farm and Game Service, Birdsong Plantation, Thomasville, Georgia, with whom I have had many profitable conferences concerning the role of fire in secondary successions of this region. As indicated elsewhere in the text Erdman West and Lillian Arnold, of the University of Florida, determined the species of plants.

LOCALITIES OF STUDY

With few exceptions all the stations studied lie within one and one-half to four miles north, east, or south of the center of Tallahassee. Forming approximately an arc, the area including them is on the average about three miles wide. Beginning at the S. K. Meginnis estate on the old Bainbridge road about two and one-half miles northwest of the city, the belt circles clockwise almost 180 degrees to include Myers Park and Perkins Woods, which lie about one mile southeast of the center of Tallahassee and to the right of the Perry highway.

Paradoxically enough, some of the fields and woods on the outskirts of the city are more nearly—if not absolutely—free from the drastic interference of man than are the forests out in the country, where fires, purposely set, almost everywhere influence the progress and order with which the various species or associations succeed one another and develop toward a climax forest association. If one holds to the opinion that he should not consider vegetational development too near the influence of local urban activities but ought rather to seek the presumably less disturbed plant life far out in the rural districts, he is likely to see only plant successions that have been influenced and more or less complicated by drastic lumbering operations, grazing cattle, rooting hogs, and cataclysmic fires. The relatively rapid and simple vegetational sequences (plant successions) seen in the immediate environs of Tallahassee are not so evident in severely molested rural tracts of woods.

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[6] Laura Gano, "A Study in Physiographic Ecology in Northern Florida," *Botanical Gazette*, Vol. 63 (1917), pp. 337-372.

ASSOCIATIONAL CONCEPTS

Following Braun-Blanquet[7] and without involvement, I am simply applying the term *plant association* to "pieces of vegetation with similar combinations of species." For example, the many patches of forest characterized by short-leaf pine, oaks, and hickory of the Tallahassee red hills region may be synthesized into the *pine—oak—hickory association* concept; pieces of vegetation characterized by broom-sedge and dog-fennel constitute the *broom-sedge—dog-fennel association*[7a]. The dominant and outstanding species are used to name the association. In the schematic drawing and tables of associations and species I have included species usually noticed in the association during repeated field trips and studies. I make no claims that the plants noted constitute a complete or unmodifiable check list.

Concerned primarily with local plant succession—vegetational changes or development from field through various forest types or stages—and the more obviously important environmental factors related thereto, I have made no attempt to break down the vegetational unit, the *association,* into any of its subordinate plant communities. Neither have I tried to incorporate into the association concept such vegetational characters as physiognomy and ecological structure, as proposed by Nichols[8]—features of which one would necessarily take cognizance in certain types of studies. In accord with Braun-Blanquet[9] I have considered individual examples of an association as stands. *Pine association,* for instance, is the abstract type, and *pine stand* the concrete example. Again following the proposal of Nichols[10] and the recommendation of Braun-Blanquet[11] I sometimes use the term *association* in an abstract, at other times in a concrete sense. However, there should be no confusion, for the context indicates the use: concretely, this is *a* pine association; or abstractly, *the* pine association is common in the vicinity of Tallahassee.[12]

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[7] J. Braun-Blanquet, *Plant Sociology,* English translation of *Pflanzensoziologie* by George D. Fuller and Henry S. Conard (New York: McGraw-Hill Book Company, Inc., 1932), pp. 22-23.

[7a] In this paper an em-dash instead of a hyphen is used to connect the plant names that make up the association name, on account of the fact that so many of the plant names are themselves hyphenated.—Editor.

[8] George E. Nichols, "A Working Basis for the Ecological Classification of Plant Communities," *Ecology,* Vol. 4 (1923), p. 17.

[9] *Op. cit.,* p. 23.

DETERMINATION OF SPECIES AND NOMENCLATURE

Harper's[13] work on the vegetation of the Tallahassee red hills, fortified with a representative plant list, served as a substantial aid in recognizing and locating species, as well as a good background for general topographic and soil features of the region.

Erdman West, Botanist in charge of the Herbarium, and Miss Lillian Arnold, Assistant Botanist, both of the Agricultural Experiment Station, University of Florida, determined or verified the identifications of nearly all species. Credit is due to them for valuable and prompt aid, but the writer assumes all responsibilities for possible errors. Nearly all nomenclature used herein follows Small's manual.[14] Authority is cited for names from other sources.

SECONDARY SUCCESSION FROM ABANDONED FIELDS TO PINES

Soils of the local fields are laden with seeds of many species of plants: annual, biennial, perennial herbs, and even shrubs and trees of forests which will never manifest themselves as growing plants as long as the area is subject to tillage. But let a field lie fallow for one season and the herbs with many seeds already in place appear almost at once in great numbers and robustness. Because of a soil already favorable for plant growth, species on relapsed fields become established and plant associations supersede one another much more rapidly than in certain barren areas of rock or sand where soil sufficient to support plants accumulates very slowly. The type of plant succession starting in an old field, for example, is known as a secondary succession. Primary successions are associated with slowly produced soil, and may be seen, for instance, taking place on seaside dunes, where waves and wind first have to build mounds of sand suitable for pioneer plants.[15] There are, of course, other kinds of primary and secondary successions.

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[10] *Op. cit.*, p. 16.

[11] *Loc. cit.*

[12] The subject of plant associations receives extensive and critical treatment in such works as:

Frederick E. Clements, *Plant Successions, Pub. 242* (Washington: Carnegie Institute, 1916).

Frederick E. Clements, and Victor E. Shelford, *Bio-Ecology* (New York: John Wiley and Sons, Inc., 1939).

H. A. Gleason, "The Individualistic Concept of the Plant Association," *The American Midland Naturalist*, Vol. 21 (1939).

J. E. Weaver and F. E. Clements, *Plant Ecology* (New York: McGraw-Hill Book Company, Inc., 1929).

[13] Roland M. Harper, "Geography and Vegetation of Northern Florida," *Florida Geological Survey, 6th Annual Report* (1914), pp. 266-279.

[14] J. K. Small, *Manual of the Southeastern Flora* (New York: Author, 1933).

Although predominatingly crowded with annuals and biennials like ragweed, horse-weed, Spanish-needles, *Isopappus divaricatus,* cocklebur, Mexican clover, evening primrose, buttonweed, coffee-weed, and partridge-pea, the annual-biennial association of the abandoned field may already in the first year show vanguards of the next association—occasional single-stemmed plants of the perennial dog-fennels, *Eupatorium compositifolium* in the well drained areas, and *Eupatorium capillifolium* in moist places, especially depressions. About the third year small bunches of broom-sedge *(Andropogon virginicus, A. Cabanisii)* and other perennials appear along with the, by this time larger, several-stemmed tufts of dog-fennel. In one instance the field representing the second or third year of secondary succession was in places characterized by what appeared to be almost exclusively partridge-peas (*Chamaecrista robusta*), but surprisingly enough under the solid canopy of this colony of annuals there could be seen healthy clumps of broom-sedge, apparently not handicapped by the shade cast by partridge-peas. Broom-sedge and dog-fennel, by early establishment of their perennial underground parts, are prepared to challenge the future occupancy by, or persistence of, the annual partridge-pea or other short-lived annual herbs. Once started, perennial herbs like dog-fennel and broom-sedge shut out the annuals by preempting the soil with a mass of rootstocks below and shoots above, making it impossible for seeds of the annuals to work into and under a moist cover of soils. This phase of exclusion is a mechanical one. But in addition to this handicap imposed on them, annuals starting from seed, when and if they do, must each year develop new roots with which to compete against perennials, whose roots and shoots, in place during the winter and filled with stored food, are able to take the lead in the spring.

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[15] Herman Kurz, *Florida Dunes and Scrub, Vegetation and Geology,* Bull. 23 (Tallahassee: Florida Geological Survey, 1942), *passim.*

Fields several years old are ruled by broom-sedge and dog-fennel. Here the annuals or biennials, once so rank and numerous in the first and second year stages, are depauperate individuals and found only in pockets not yet taken by broom-sedge and dog-fennel. Annuals or biennials of the summer and fall, like ragweed, horse-weed, partridge-pea, button-weed, Spanish-needles, *Isopappus divaricatus*, evening primrose, and others, so large in earlier stages, are now dwarfed in size and reduced in numbers. These lingering, isolated plants are thought of as relics harking back to a former time when conditions for them were more favorable. Reference to annuals as relics in a later perennial stage is of course figurative; for no individual annual plant actually persists from the annual stage of succession; it is rather that the species lingers on by virtue of chance germination of seeds and precarious survival of seedlings thus started in a habitat no longer very amenable for pioneering annuals. The consideration of perennial herbs or trees as relics is different. In these cases it is actually the *individual* as well as the species that hangs over into a later stage.

In the perennial stage are a number of other perennials each in its own way able to compete with or persist in spite of the dominant broom-sedge and dog-fennel. These species, even though they play a subordinate role, are definitely a part of the *dog-fennel—broom-sedge association.* Most of them, not very expansive plants and apparently not requiring a maximum of water and light, are able to establish themselves and to hold on in the unoccupied interstices of the larger dominant broom-sedge clumps and dog-fennel tufts.

But almost as soon as herbaceous perennials have closed out their predecessors, they themselves must yield to trees and woody perennials which, by the yearly increments of length and branches to roots and stems already in place, are able to reach heights for light and depths for water and minerals that are never accessible to perennial herbs whose roots and stems, however efficient in lateral expansion, are nevertheless limited in vertical extension.

Sun-loving pines raising their stems and leaves aloft incidentally cut down light intensity beneath them to such a degree that dog-fennels and broom-sedge are unable to survive very long after the pines tower over them. As a matter of interest, before a dog-fennel—broom-sedge field is very old, the pines with their dark green needles manifest themselves in bold contrast. Really the pines are present in the spaces as small seedlings or saplings several years before they are large enough to be seen from a roadside. In other words, the pines may come in as seedlings as early as the second year after a field has been abandoned, but their small stature as seedlings makes their early presence in a field of robust herbs inconspicuous and easy to overlook.

Observation discloses that dog-fennels also begin to filter in between the annuals or biennials the first year the latter are established; ordinarily the broom-sedges start the second year. Because of the modest size of these perennials in their initial stages, compared with the rankness of the annuals, they are not noticeable until about the third or fourth year, when their larger shoots and abundance compare well with, if indeed they do not overshadow, the annuals. It must be clear then that herbs, like the pines which follow them, are present much sooner than is obvious on account of early inconspicuous sizes. As Gleason[16] has emphasized, plant succession proceeds from one stage to another with a gradation that is much finer than one realizes who thinks of plant successional stages as definitely compartmentalized, or who sees only the distinctive plants or plant associations. The various stages spoken of in this context are thought of as expressions of convenience rather than sharply delimited or "jumpy" stages. Succession does not proceed from one stage to another by long leaps.

Development of the pine association replacing the dog-fennel—broom-sedge association may thence proceed in one of at least two directions: (1) rather directly and rapidly from a short-leaf pine association to a pine—red-oak—water-oak—laurel-oak association, with mockernut hickory added in the later stages, and on to a magnolia or magnolia—beech climax; or (2) from dense short-leaf pine to a pine—red-oak—post-oak—black-oak—mockernut hickory association, a stage more or less indefinitely arrested, and typified by an abundant undergrowth of perennial grasses and forbs (herbs other than grasses), and low thickets of sprouting trees and shrubs. The first course of development takes place when burning, cutting, and grazing play a negligible role; the second sequence results when fire, ax, and stock profoundly influence the vegetation. In this second sequence relations of all the factors operative in the variable types of associations evolved are not always clear. But abundance of seed in proximity, sensitivity and reaction of different species to fire, and to particular light conditions, grazing, and cutting operations, together with the different time schedules that species follow in settling into the

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[16] *Op. cit.*, pp. 92-110.

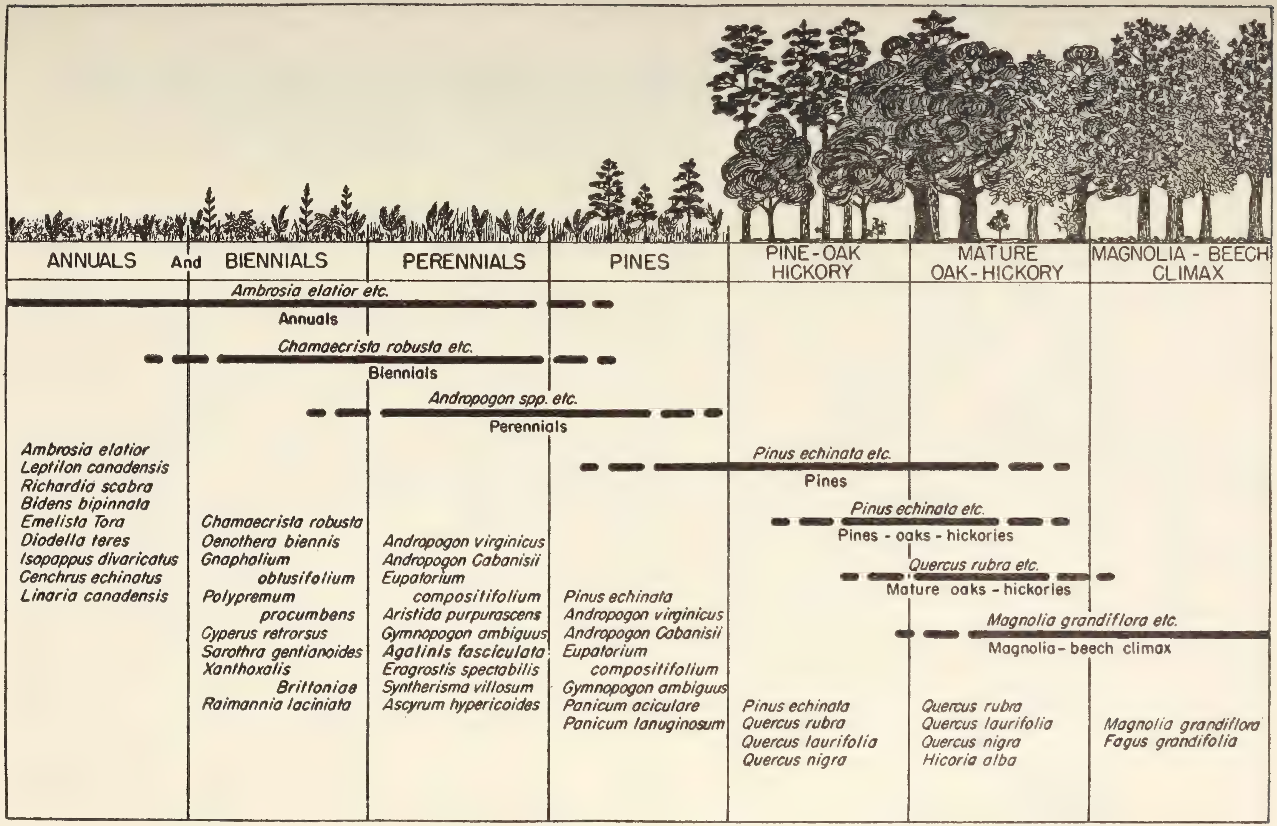

PLATE 1

Plate 1. Diagram illustrating the principal stages in a direct secondary succession of the Tallahassee red hills. (Drawn by W. D. Wilson, Draftsman, Florida Geological Survey.)

community, all complicate or modify in varying degrees the successional development and species combination of a given stand.

FROM PINE TO MAGNOLIA—BEECH CLIMAX

Pine Association. Where the pines have taken possession and developed without hindrance, it is not rare to see stands crowded with twenty-five, fifty, or even one hundred trees within a twenty-five foot radius—an area approximating 1900 square feet. The pines often range in diameter from one to seven inches (sometimes up to eight or nine inches) at breast level, and their height runs from twenty-five to fifty feet. While the trees are about this size and height their tops form a dense low canopy under which the weakened light permits very few plants to grow. Only isolated dwarfed individuals of ragweeds, partridge-pea, dog-fennel, broom-sedge, and panic-grasses (relics of previous conditions), or scattered plants of elephant-foot, partridge-berry, longspur-orchid, French-mulberry, and rosin-weed (pioneers of a future brighter pine woods), inhabit the dark needle-littered floor.

Sometimes fire, ax, or even competition between the pines themselves will eliminate enough trees to allow more light to filter in. Also with time—thirty or forty years or so—the ceiling of foliage will lift and break enough to permit lateral and local entrance of light. In some instances the pines are somewhat scattered from the very beginning. It is in situations such as these that the pioneers listed above are reenforced by others characteristic of the open pine woods—species of grasses, sunflowers, ironweeds, golden-asters, goose-grasses, and others listed in Table 1.

Pine—Oak—Hickory Association. Sooner or later numerous saplings of red-oak, water-oak, and laurel-oak start in the shade of the pines—soon, if the pines are not too thick; later, if the pines are dense, when time or circumstance shall have thinned them out. If the pines are not too thick from the beginning and fires not so severe or frequent as to eliminate the species of oaks in question, the latter may appear in good numbers before the pines are more than fifteen feet high. In some situations, in fact, the oaks may be as numerous and almost as large as these young pines themselves. Because of their thicker bark pines will survive a fire with no worse injury than singed needles, whereas young oaks will usually be killed back to stumps in the ground, from which they will sprout anew if not burned too deeply. The pines do not survive by sprouting: fire either kills them outright or leaves them alive without loss in height. By virtue of having more individuals in the beginning and an earlier start than the oaks, the pines will, in a periodically burned area, usually be represented by more and larger survivors, tending thus to dominate over the oaks for a long time, until the ax or natural death removes the last relic pine. Eventually the oaks, hickories, and other hardwoods will come to characterize the association; for pines, not germinating in their own shade or in that of oaks, have no offspring to perpetuate them, while the oaks and hickories can come in under the pines and hold dominance until magnolia and beech, in turn germinating in the shade of the oaks and other hardwoods, displace them.

In one habitat two blocks north of Tharp street and two blocks west of Meridian road, unburned for a long time, if ever, and rich in needle duff, magnolia saplings one to two feet high were coming up in the midst of a pure, oak-less stand of short-leaf pines, ranging from two to seven inches in diameter and with a density of fifty trees per twenty-five foot radius. Growth ring counts of cores taken indicated the ages of the pines to be from fifteen to thirty years. Such evidence demonstrates that in certain cases—where fire has been scarce or absent, and there is abundant leaf mold—magnolias may even appear as early as the oaks. In fact, in this stand, only thirty years beyond the dog-fennel—broom-sedge stage, there are still relics of that association in the form of beard-grass, love-grass, and even Mexican-clover—species belonging to the annual stage. However, although the fire-sensitive magnolias may come into an unburned open pine woods very early, the indications are that usually the oaks and hickories antecede them. The severity and frequency of burning determine to an important degree what species of oaks shall settle in the pines, but even mild fires preclude or eliminate magnolia. Situations also apparently inimical to the establishment of magnolia are tangles of grass and vine, herb, and sprout growth, such as are induced by frequent fires, the ax, or grazing in an open pine forest or in mixed hardwoods; but perhaps it is the fire *per se* which has kept the magnolias out of such growths.

Offsetting the foregoing places where magnolia fails to establish itself, however, is the fact that it will come up abundantly in the shade of pines, in dense stands of young hardwoods, and in certain old mixed woods, provided only that the ground is rich in leaf mold, relatively free and clean of ground cover of herbs, vines, and sprouts, and untouched by fires.

Another example of a dense pine—oak—hickory stand favoring early invasion by magnolia exists at the Miccosukee road about seven-tenths of a mile southeast of the juncture with the Centerville road. This stand is characterized by short-leaf pines about six inches in diameter, with scattered red-oaks, water-oaks, and laurel-oaks almost as large. Persistent char-marks on the bases of the pines indicate the occurrence of fires in the past, but the present thick leaf mold and forest floor devoid of sprouting oaks show that there has been no recent burning. Even with mature oaks at hand and young hickories developing, the forest is still predominatingly pine.

Magnolia—Beech Climax Association. In the pine—oak—hickory association there are many saplings of magnolia and a few beeches making their appearance. It is easy to picture this stand converted into magnolia—beech climax association fifty years hence, probably still harboring a few relic pines, oaks, and hickories that will hark back to the present. The size of the present trees suggests a forest that began with pine saplings about thirty-five to fifty years ago. This estimate is based on cores examined by the writer and on growth ring studies made of *Pinus echinata* by MacGowan.[17] The perplexing multiple growth rings of magnolia do not permit a reliable estimate of the number of years that will have to be added to the above thirty-five to fifty years before the present pine—oak—hickory stand will be characterized by mature magnolias. However, beech trees develop at about the same rate as magnolia; and growth rings of beech are determinable. MacGowan's table[18] shows that under forest conditions beech requires about seventy-five years to reach a diameter of fourteen inches. Beech and magnolia of this size would make a representative climax. It seems therefore that for magnolias to reach twelve to fifteen inches in diameter under forest conditions another fifty to seventy-five years would have to be added to the fifty years of

Plate 2. *Types of Plant Associations.*

Top: *Fore,* broom-sedge with short-leaf pine coming in. *Rear right,* pine—deciduous oak—hickory subject to fires.

Middle left: Dense young short-leaf pine stand, burned at times.

Middle right: Unburned short-leaf pine—mixed oak—hickory, with invading magnolia.

Lower left: Magnolia climax, showing little undergrowth and a paucity of young climax saplings.

Lower right: Magnolia—beech climax with open understory and practically no reproduction. Large beech in foreground.

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[17] W. Leroy MacGowan, "Growth Ring Studies of Certain Trees of North Florida" (Unpublished Master's Thesis, Florida State College for Women, 1935), Chart 3, p. 31, Table III, pp. 79-80.

[18] W. Leroy MacGowan, "Growth-ring Studies of Trees of Northern Florida," *Proceedings of the Florida Academy of Sciences*, Vol. 1 (1936), pp. 57-59.

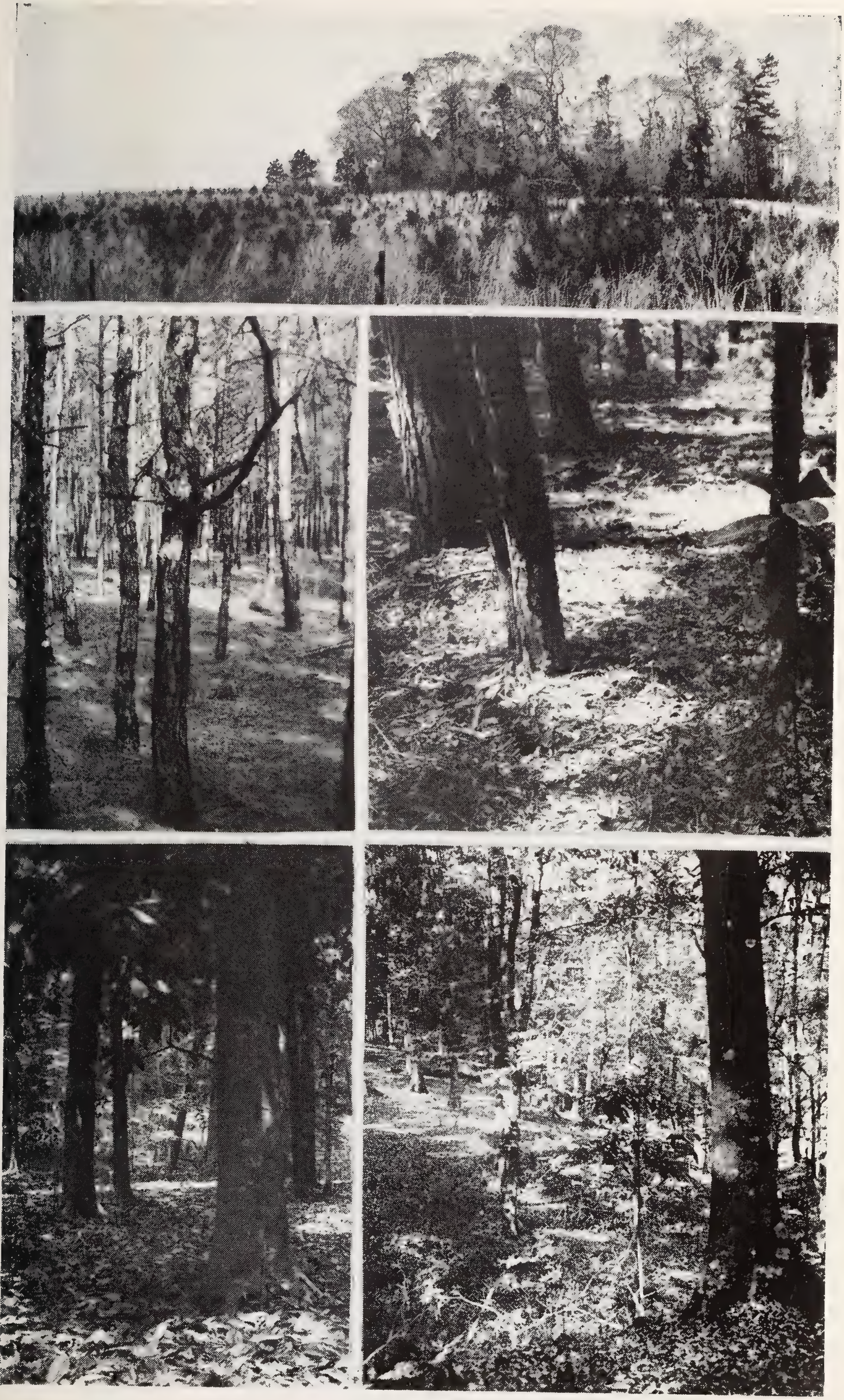

Plate 2
(Legend on opposite page)

pine—oak—hickory development. Thus, under favorable conditions, one hundred to one hundred and fifty years of plant succession would probably change a field into a mature magnolia—beech climax with some trees attaining a diameter of fifteen inches and a height of seventy-five feet. Conceivably a minimum time span of one hundred years might suffice for an area never burned or disturbed in any way to go from fallow field to final climax—for example, the station near Tharp street and Meridian road discussed above.

Sassafras and Persimmon Thickets. Locally in the fields of annuals or dog-fennel—broom-sedge, thickets of sassafras or persimmon sometimes develop instead of pines. I have seen no stands of this kind sufficiently extensive or long enough established to justify much discussion. However, as an early feature of the undergrowth of these communities, there are young red-oaks, laurel-oaks, and short-leaf pines. With the development of these species there should, it seems, result a pine—oak—hickory stage with a number of persimmon or sassafras relics persisting from the earlier association.

Magnolia versus Beech. Where beech competes with magnolia no obvious advantage seems to be gained by one over the other. Being evergreen the magnolias have the longer growing season for food building; the deciduous beech, on the other hand, seems to offset its shorter season of activity by a fuller utilization of all available light in the various levels of the forest. As a rule the foliage branches of the beech reach much lower down into the understory of forest canopy than do those of the magnolias. In crowded climax conditions, in fact, the magnolia stem system seems to be cramped and of narrow outline, while the beech branches spread laterally and even sprawl downward under and amongst the interspaces of the more or less restricted limbs of neighboring magnolias. All in all, however, it seems to be about an even contest.

Other Ecological Equivalents of Magnolia. It may be that, next to magnolia and beech, the pignut hickory is the most shade-tolerant of all trees. In the C. W. Anders magnolia forest at the north end of Lake Iamonia is located the largest almost pure magnolia stand in this region. In this stand pignut hickory is found here and there as a large tree. Under the magnolias are many small pignut hickory saplings less than six feet high. Browsed by cattle, however, it seems in this forest to have no chance to develop. For a number of reasons definite conclusions as to the role of the species can not now be reached; observations have been limited, no young pignut hickories larger than the mutilated ones are present, hogs range this habitat, and there is evidence of disturbance in the climax forest. Nevertheless, the pignut hickory and the American ash do appear to be at the same time the latest hardwoods to enter a mixed forest and the last to be expelled by magnolia.

Not specifying location, Watson[19] speaks of a Magnolia—Tamala—Ilex mesophytic climax in northern Florida. In his Welaka area study Laessle[20] writes of a "Magnolia grandiflora—Ilex opaca association." He also considers *Tamala Borbonia* (red-bay) and *Ilex opaca* (American holly) as forming a part of the mesophytic climax hammock and sharing dominance with *Magnolia grandiflora.*[21] Laessle[22] states that:

> These climax hammocks are characterized by an arboreal vegetation composed of bull-bay, laurel-oak, red-bay, pignut (*Hicoria glabra*), American holly (*Ilex opaca*), water-oak (*Quercus nigra*), black-cherry, live-oak, and some sweet-gum (*Liquidambar Styraciflua*) in the more moist portions. Loblolly-pine, basswood (*Tilia floridana*) and cabbage-palm are occasional.

Except for the presence of the cabbage-palm and the prominence of holly and red-bay on the one hand, and the absence of beech on the other, this association is very suggestive of the modified climax-hardwood forest under discussion farther on. Laessle is fully cognizant of fire as a factor in the development and existence of the *Magnolia grandiflora—Ilex opaca* association. He makes no commitment, however, as to whether selective or periodic cutting is a characterizing influence of his climax hammocks.

In none of the stations included in my studies have I seen American holly sharing a habitat on equal terms with magnolia. The hollies noticed were rare, isolated, and small specimens. Neither have I seen red-bay in a typical magnolia—beech climax situation. Indeed as a large tree red-bay is rare in this section. Nor have I seen the two species in question coming up as saplings under the shade of magnolias. In the Tallahassee red hills the holly and red-bay can therefore not be considered as co-dominants of magnolia and beech. I have seen the two species with magnolia in modified climax-hardwoods (*q. v.*); the same modified climax-hardwoods would also display pignut, laurel-oak, white-ash, sweet-gum, Walter's-pine, red-mulberry, basswood, and others. In other words, the red-bay when present at all, and the commoner holly are in this section simply a part of modified climax-hardwoods or of broken climaxes in general.

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[19] J. R. Watson, "Florida," in: *Naturalist's Guide to the Americas* (Baltimore: The Williams and Wilkins Company, 1926), pp. 427-440.

[20] Albert Middleton Laessle, *The Plant Communities of the Welaka Area* (Gainesville: University of Florida, 1942), p. 37.

[21] Laessle, *Op. cit.*, pp. 36-40, 96-68.

[22] Ibid., pp. 37-38.

Reproduction of Magnolia and Beech. In the relatively direct tree successions just described degrees of shade tolerance play the important role. The sun-loving pines are least shade-tolerant; the oaks and hickories, tolerating more shade than the pines, establish themselves under the latter; and the magnolias and beeches, most tolerant of all, spring up under the oaks and hickories. Each succeeding tree association gradually outgrows and replaces its predecessor; magnolias and beeches, the last to come, develop into the climax forest association. Ordinarily none of these species, not even the magnolia nor the beech, starts and develops under the canopy of a mature forest of its parent trees. Like the associations preceding them magnolia and beech seem to succumb to their own shade or influence. Although I have seen no instance of magnolia or beech saplings of varying sizes and ages coming up under parent trees, I nevertheless consider these species as climax trees by virtue of the fact that they alone, other factors being favorable, start under the shade of any of the local mesophytic tree communities and finally replace them. Lack of reproduction on the part of magnolia and beech within the climax is at once outstanding and perplexing, for it seems generally accepted by ecologists that the ability of a species to establish itself in the shade of the parent tree is one of the tests of a climax forest species. Whitford[23] writes:

> The whole interior of North Manitou Island, except in clearings and undrained areas, is covered with a mature maple—beech—hemlock forest. The presence of seedlings and young trees of these three in abundance and the absence of all other young trees in there indicate that the future forest growth will be the same as the present.

It appears especially striking that in the north the beech shares with its ecological equivalents, maple and hemlock, the ability to reproduce in its own shade, while in northern Florida it shares with its ecological equivalent, magnolia, the failure to do so.

Paucity of reproduction in the heart of a magnolia—beech climax suggests a number of speculations and questions. Why, for instance, do young magnolias not develop in the shade of the parent stands when at the same locality saplings do appear in the understory thicket of adjacent modified climax-hardwoods? It may be that the coarse leaves of magnolias do not make a suitable mulch. Unfavorable soil water or other conditions related to the nature of the mulch, and shallow, water-demanding roots of the old trees themselves may be involved. Do animals play a part? Magnolia seeds and seedlings are favorite foods of various wild animals and semi-wild hogs. Often the ground under a magnolia will show the work of hogs while beyond the canopy and root limits of the tree the forest floor shows no molestation. In these adjacent relatively undisturbed and fire-free areas occur the magnolia saplings. One might think that the hogs, confining their work within the limits of the tree where seeds are concentrated, simply miss the isolated seeds or seedlings strayed in the neighboring ground; but I have seen small groves of large magnolias shading ground untouched by hogs, and even here, there were no saplings under the trees. The exact role of animals is therefore also not clear to me. Aside from these uncertainties, it is very apparent that factors definitely detrimental to magnolia reproduction are fire and, in one sense, magnolia itself, where the trees are large and closely grouped, as in climaxes or even in stands of a few individuals. I have seen no perpetuation of either magnolia or beech in a closed mature magnolia—beech climax, and all my observations indicate that a new start must be made under trees that are not magnolias or beeches.

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[23] Harry Nichols Whitford, "The Genetic Development of the Forests of Northern Michigan; A Study in Physiographic Ecology," *Botanical Gazette*, Vol. 31 (1901), pp. 289-325.

While both beech and magnolia fail in reproduction in a mature climax, the two species are not parallel in all respects. Within a radius of twenty-five feet I have counted as many as twenty-five beech seedlings germinating in March, only to see them severely mutilated by leaf parasites by midsummer. Symptoms on the foliage of parent trees nearby indicated the same enemy operative on adults. Concerning beech I am not prepared to go beyond this suggestive observation. I have never even seen any germination of magnolia in a comparable climax situation.

Climax Undergrowth. Remarkably free of undergrowth, the climax is always characterized by an open, easily traversed understory. French-mulberry is the commonest shrub; here and there, according to local conditions, may occur others like strawberry-bush, silverbell-tree, southern black-haw, wild-olive, sweetleaf, and devil's-walking stick. Woody climbers are usually represented by poison-ivy, Virginia-creeper, muscadine, cross-vine, and Chinabriar. Partridge-berry and sarsaparilla are found mostly as trailers. The forbs, never abundant, ordinarily are green-dragon, wake-robin, yellow passion-flower, Virginia-snakeroot, bedstraws, crane-fly orchid, and beech-drops. Two sedges, *Carex filiformis* and *C. floridana,* are commonly present. Wood-grass is nearly always present in the climax, and the panic-grass, *Panicum Joorii,* very often. Along the banks of woodland brooks or on ravine slopes we frequently find the Christmas-fern, *Polystichum acrostichoides* (Michx.) Schott, or occasionally ferns like the moonworts, *Botrychium alabamense* Maxon., *Osmundopteris virginianum* (L.) Small, and the spleenwort, *Asplenium platyneuron* (L.) Oaks.[24] It might be well to point out that a slight variation in habitat due to topography or to the activities of man may change conditions locally enough to make a pronounced difference in the species composition; but then we are no longer dealing with a typical mesophytic magnolia—beech climax environment and its corresponding stand.

ARRESTED OR SET-BACK FOREST ASSOCIATIONS

Pine—Deciduous Oak—Hickory Association. Characterized by short-leaf pine and deciduous red-, post-, and black-oaks as well as by mockernut hickory trees, and more or less modified by cutting and grazing, the pine—red-oak—hickory is essentially a fire-delayed association. Although the pine and red-oak are the most abundant, the other oaks and hickory are present consistently enough to qualify them as regularly participating species. The association usually abounds in species and individuals of grasses, forbs, and herbaceous and woody vines, and often displays low thickets of woody sprouts brought about by injury from fire, ax, or cattle. Flowering herbs appear from spring to fall but are the showiest in late summer and autumn. In the spring, however, when dogwoods form a continuous understory of white, and the higher pines and oaks a ceiling of many shades of green, these woods are most attractive. Often marked by uncrowded trees and more or less dense and tangled low growth, the pine—oak—hickory forests offer a real contrast to the relatively crowded conditions in unburned and unmolested pine stands, where the forest floor, thick with needle litter, is almost plantless. Continually grazed, periodically burned, and cut from time to time, the pine—deciduous oak—hickory may, according to the severity of these factors, be halted as a more or less open forest for years—certainly as much as fifty years according to the testimony of longtime residents.

Pine invasion is nearly always marked by great numbers settling into an old field. Soon obliterating and overshadowing the dog-fennel and broom-sedge, the trees, mostly short-leaf pines, sometimes grow as many as one hundred or more within a radius of twenty-five feet. If not seriously molested, such colonies develop and persist as virtually pure pine stands up to fifty years or more. Because of extreme shade, other plant species and individuals are reduced to a minimum. However, where the pines, as is a common case, have been thinned out by early competition, work of man, or fire, thus allowing light to break in, and where fire subsequently sweeps periodically, there comes an opportunity for many species hitherto excluded. That is to say, drastic factors like cutting and fire are much more favorable to abundance of species than the severity of competition and reduced light conditions in a dense undisturbed stand of pine. As Harper[25] has indicated so persistently in various papers, fire favors the survival of relatively thick-barked or tough woody plants, and even of many perennial herbs which by means of protected rootstocks or other subterranean propagative parts are able to send forth new top growth following a scorching in summer or a burning of dead shoots during winter. As might be expected, the herbs so abundant and lush in the open, well-lighted and burned pine woods are depauperate, rare, or even absent in the thicker and shadier stands of pines.

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[24] Determined by Edward Porter St. John, Floral City, Florida.

Red-oak, water-oak, and laurel-oak, progressively less fire-resistant in the order listed, are usually the early pioneers in pine stands where periodic burning of varying intensity is the rule. The evergreen water- and laurel-oaks are much more readily set back by fire than the red-oak, but they keep coming back as sprouts from stumps which survive light fires, or start anew as seedlings. Ordinarily mockernut hickory comes a little later, while the post-oak and black-oak, about as immune to flames as the red-oak, appear even later than any of the five oaks previously mentioned, and apparently come as isolated individuals into the developing pine—red-oak—hickory association. In situations where fire is frequent and drastic, because of the greater fire sensitivity of the water- and laurel-oaks, the tougher post- and black-oaks, along with the red-oak, hickory, and pine, constitute the important trees of the pine—deciduous oak—hickory association. Indeed these latter five species are found alike in burned and unburned woods. Interestingly enough, unless a pine—deciduous oak—hickory woods is burned from year to year and otherwise maltreated, the post-oak and black-oak are scarce if not absent; and most of the species of herbs, grasses and forbs, so typical of pine—deciduous oak—hickory, are decidedly smaller and less abundant if not wanting. It appears that the very same pyric factor which practically eliminates the evergreen laurel- and water-oaks provides opportunity for invasion by and favors survival of the more fire-resistant deciduous post- and black-oaks. If, on the other hand, the habitat escapes the influence of fire, the post- and black-oaks play an inconspicuous role and eventually fade out, while the red-oak (usually present and already established), water- and laurel-oaks (always trying), mockernut, sweet-gum (starting almost anywhere except in heavy shade or fire-swept areas), sour-gum, red-mulberry, pignut hickory, and others gradually assemble and develop into an evergreen oak—hardwood—pine forest.

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[25] Roland M. Harper, "Geography and Vegetation of Northern Florida," *Florida Geological Survey, 6th Annual Report* (1914), pp. 184-185. "Vegetation Types; Natural Resources of an Area in Central Florida," *Florida Geological Survey, 7th Annual Report* (1915), pp. 147-165, 170-171. "Natural Resources of Southern Florida," *Florida Geological Survey, 18th Annual Report* (1927), pp. 82-103.

Frequency or severity of burning, duration of fireless period, extent of cutting, intensity of grazing—all these factors in varying degrees bring about mingling between fire-tolerant and non-tolerant species, or paucity of some types, and thus create a variety of forest communities. For example: a dense stand of young short-leaf pine with only a scant litter of dry needles may well be scorched so slightly or infrequently that laurel- and water-oaks, facing flames not too drastic, can develop along with the red-oaks; but where fire is frequent and severe, as it must be in the pine—deciduous oak—hickory association with its abundant dead and dry undergrowth in winter, the laurel- and water-oaks and sweet-gum tend to be absent, while post-, red-, and black-oaks as well as mockernut hickory are apt to be the species present.

In situations with repeated severe fires but no serious thinning out of trees by burning itself, by cutting, or by other factors, red-oaks, black-oaks, post-oaks, mockernut hickory, water-oak, dogwood, and the ever present short-leaf or occasionally loblolly-pine constitute almost all the trees of the forest. Here sweet-gum and laurel-oak, often found with water-oak but more sensitive to fire, are scarce or absent. Stands of this kind with a profuse understory of dogwood may be very shady, and the forest soil at times very dry, with herbs quite sparce.

Evergreen Oak—Hardwood—Pine Association. Once the practice of burning and grazing is abandoned, laurel- and water-oaks come back quickly as a conspicuous element, and the forest rapidly loses much of the undergrowth of jumbled forbs, grasses, sprouting woody plants, and interwoven vines. Freedom from burning soon results in the growth of the fire-sensitive evergreen laurel- and water-oaks, red-mulberry, sweet-gum, and sour-gum, all from invading seeds, or else allows stumps already in place but hitherto periodically scorched now to develop their sprouts into a phalanx of young trees. With increasing dominance of hardwoods the shortleaf and loblolly-pines fade out altogether, and instead the more shade-tolerant dark green Walter's-pine may make its appearance.

In areas formerly typical of fire-produced pine—deciduous oak—hickory, which have later been freed from burning, I have seen veritable thickets of water-oak, laurel-oak, and red-oak, shortleaf pine, red-mulberry, live-oak, sour-gum, mockernut hickory, dogwood, and crab-apple, with a density as great as two hundred trees within a circle of twenty-five foot radius. Led in abundance by water-oak, these young trees ranged in height from six inches to fifty feet, and in diameter from one-half to six inches. Naturally enough in summer, with trees in full foliage, the thickets are weak in light, but because of a good leaf mold and clean floor, magnolias soon find their way into these habitats, especially if seed-bearing trees are not too distant. Even with parents far removed infiltration of magnolias or beeches begins in due time.

Parts of Perkins woods on the southeastern edge of Tallahassee, cleared and sometimes burned in past years but not in recent times, contain a variety of large scattered evergreen oaks and other hardwood trees with a dense undergrowth of saplings in between. Rich in leaf mold and scant in ground-cover growth, this station shows magnolia coming up in various situations. Under one large live-oak and headed upward through the central leafless skylight provided by extreme centrifugal divergence of its limbs, I counted ten magnolia saplings. One large laurel-oak (twenty-two inches in diameter and sixty feet high) was surrounded by six magnolia saplings five to ten feet high within twenty-five feet of the trunk. Locally the woods showed as many as one hundred trees within a radius of twenty-five feet, different species running from six inches to forty feet high. In such thickets, containing laurel-oak, water-oak, red-oak, sweet-gum, mockernut hickory, red-mulberry, and pignut hickory, half a dozen magnolia saplings were not unusual.

Modified Climax-Hardwoods. Small local clearings produced by selective cutting or by windfalls in the magnolia—beech climax are not immediately resettled by young magnolias or beeches. In making observations for the present paper I have seen nothing to support MacGowan's[26] contention that the smaller the clearing the sooner it will be repopulated by magnolias, and that the larger the devasted area in the climax the farther it is set back in the successional development.[27] It seems rather that magnolia—beech stands locally depleted of trees now offer a very favorable habitat for a number of strongly mesophytic and very fire-sensitive arboreal species that can not survive in direct competition with magnolia or beech. Sometimes all the tree species that commonly play a role in the various stages of succession from a relapsed field to a climax forest, may be concentrated into one complex community. Locally such a mixed forest area may contain in miniature each of the habitat types that follow one another in a typical unhindered succession. Recent cutting by ax, dragging of logs, and uprooting of trees by storms can create in the forest open spaces and loose soil, not very unlike conditions in a field, where pioneer ruderals and later pines, oaks, and hickories may find foothold. In due time removal of dominating magnolias and beeches gives, under certain conditions and circumstances, access to shade-tolerant trees. In short, all kinds and degrees of conditions, from minor changes to severe havoc, bring about a telescoping and scrambling of representative successive plant associations into one grand mixture of forest trees.

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[26] W. Leroy MacGowan, "Growth-ring Studies of Trees of Northern Florida," *Proceedings of the Florida Academy of Sciences*, Vol. 1, (1936), pp. 57-59.

The great variety of herbs and forbs found in these modified climax-hardwoods is due, of course, to the same causes. Pioneer herbs of fields and pines, and herbs and forbs of modified hardwoods and of climax forest grow here in great confusion.

Tree species often found in very old, seldom burned mesophytic hardwoods, or in the gaps of emasculated climaxes are: *Hicoria glabra, H. microcarpa, H. megacarpa, Pinus glabra, Fraxinus americana, Ilex opaca, Morus rubra, Liquidambar Styraciflua, Quercus Prinus, Q laurifolia, Q Schneckii, Tilia heterophylla, T. georgiaana,* and *T. carolina.* These trees can grow all around magnolia or beech climax relics but are not, except in rare instances, found as part and parcel of genuine magnolia—beech climax. As a rule they are unable to establish themselves under the patriarchal climax trees; repeated burning may in one place bring in fire-tolerant black- or post-oaks or mockernut hickory so typical of the pine—deciduous oak—hickory; while freedom from the pyric factor may in another spot favor the invasion of fire-sensitive laurel-oak or sweet-gum, and later the incursion of the other apparently more mesophytic and less fire-tolerant species discussed above.

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[27] With the aid of an ingenious diagram MacGowan has summarized the successions of the Tallahassee red hills. It seems proper to state that some of the views once advanced by the writer and partly in agreement with those expressed in MacGowan's paper have had to be abandoned or modified during the progress of these more recent studies.

Just what the combination or series of factors is that enables the above-listed group of fire-sensitive trees to "get the drop on" magnolia I do not know. It may be that these very mesophytic deciduous hardwoods can survive the occasional or mild fires which are yet severe enough to preclude effectively the establishment of the more sensitive magnolia or beech climax trees. According to circumstancs, there may be present magnolia or beech relics—few or many, sometimes scattered singles, again groups of trees—which give a tinge of climax to this type of association. This suggestion of climax conditions, however brought about, together with the many extremely mesophytic hardwood species present, has led me to refer to these communities as *modified climax-hardwood* associations. In using this term I am fully aware of the fact that an attempt to define or name such multi-varied hardwood complexes is more a matter of verbal convenience than ecological precision. On the other hand it does not seem desirable to lump these modified climaxes as well as several other types of hardwood forests all as mixed hardwoods or mixed climaxes; for these catch-all terms are too vague and general to cover the variety of specific types of hardwoods where so many possible species or combinations must be considered.

The nearly constant absence of young magnolias of successive age levels in these modified climax-hardwoods where large trees create an open but shady understory, and, on the other hand, the frequent presence of such magnolias in young, unburned pine—deciduous oak—hickory associations, rule out the supposition that the hardwood complexes in question are a stage regularly or necessarily antecedent to the magnolia—beech climax.

When fire is kept out of the modified climax-hardwoods, magnolias and beeches may occasionally germinate under the parent tree, but I have seen none surviving under old ones. Colonization of magnolia may take place in heavily mulched, relatively herb-less soils characteristic of the young hardwood thickets which often fill in gaps or open areas of forest caused by the violence of storm, clearing, or fire. Such colonization has been observed, for example, in the thickets between large scattered trees of gums, oaks, pignut, mulberry, and Walter's-pine.

Magnolias may also settle into certain relatively open gum—oak woods where the adverse pyric factor is not operative. In a grove of sweet-gums and water-oaks at Magnolia Heights, I counted respectively twelve sweet-gums and three water-oaks within a circle of twenty-five foot radius; their diameters ran from two to fourteen inches. This grove, with no signs of fire and about twenty-five to thirty years old, revealed twenty-three one-foot tall magnolia saplings in spite of evident grazing.

Judge Oven's woods, two miles east of Tallahassee, is today an excellent example of a *modified climax-hardwood* rich in mature arboreal species. Almost all the species of trees of the region are concentrated there. Until 1936 a part of the forest was pure magnolia and beech. At that time lumbering operations claimed the stately adults. The gaps thus formed were quickly filled by colonies of sweet-gums and silverbell-trees (*Halesia diptera*) or by loblolly-pine *(Pinus Taeda)* and short-leaf pine (*P. echinata*), the gums or pines being crowded one hundred trees to a circle of twenty-five foot radius. At present, seven years after the cutting, although the floor is well mulched and free of ground vegetation, there are as yet no seedlings of magnolia or beech. With continued exclusion of fire the latter might appear within the next five, ten, or twenty-five years. I cannot be definite about the time, but the point is that, even with mature trees left nearby to furnish seed it was not magnolias but gums, pines, and silverbells that took first possession of those suddenly opened areas with their rich forest soil but exposure to bright sunlight.

In general I have noticed that recent clearings in climax or old modified climax-hardwood forest are usually first invaded by such species as Walter's-pine, loblolly-pine, short-leaf pine, sweet-gum, laurel-oak, water-oak, or silverbell in varying purity or in combinations—not by magnolia or beech. Sweet-gums and laurel-oaks usually play a prominent part as gigantic trees in hardwoods. Unlike the pignut hickory, red-mulberry, and basswoods, they appear under the short-leaf pine early in succession. Tolerating quite a range of light, water, and soil conditions, sweet-gums and laurel-oaks come early and keep on appearing under almost any kind of forest canopy and conditions, except those of the magnolia climax. It is not uncommon to see these two trees shooting straight up through a maze of spreading live-oak branches. In fact, as stated in another connection, the extreme spreading habit of live-oak limbs often produces a central leafless opening through which the straight trunks of gum and laurel-oak tower above the live-oak. Almost ubiquitous and tolerating a variety of conditions, these two species are nevertheless seriously checked by the fire that often sweeps the early successional stages of a secondary succession, and by the dominance of magnolia and beech in the final climax stage.

The relations of the live-oak to laurel-oak and sweet-gum and to other hardwoods in general merit some consideration. The live-oak, although frequently appearing in the extremely shady hardwoods, occurs there as a relatively spindly tree which became established in an earlier and sunnier stage when competition for light was not as keen. Sensitive to fire like other species of the modified climax-hardwoods, the tree is present in this association partly for the same reason as the others—namely, more or less freedom from burning. As indicated above, the shade of this haven prevents live-oak's reproduction, and consequently causes its ultimate elimination by more shade-enduring species. Even in the open spaces where the live-oaks seem so imposing the species has its restrictions. Ample light allows it to spread in picturesque fashion, but fire limits its choice of habitat to low moist grasslands, borders of ponds and lakes, protected roadsides, and the vicinity of dwellings. However, there are many such places; consequently, the live-oak, with an abundance and apparent dominance peculiarly accounted for, does not betray how unsuccessful it really is against adverse factors like fire in the open, shade in the forest, or a combination of both.

Walter's-pine, often appearing in numbers and situations like a weed, is a universal element of hardwood complexes and mixed climaxes. The most shade-tolerant of the pines and seemingly as shade-enduring as most hardwoods, the relic trees of Walter's pine often form a conspicuous dark green element in the skyline or display gigantic trunks under the cover of the forest. The ecological relations and competitive status of the basswoods in the modified climax forest are as yet unknown to me. In most cases large magnolia or beech trees left as remnants in these climax-hardwood complexes and obvious evidence of cutting indicate clearly that these extremely modified woods hark back to climax conditions.

In some instances, however, where the modified climax-hardwoods show a variety of large old deciduous trees, little or no evidence of catastrophe, a clean understory, and only a single beech or magnolia here and there, the chain of factors involved to produce the association can only be conjectured. At any rate associations of this nature offer the nearest local counter-parts of northern deciduous forests and their concomitant "spring flowers." One such mature stand, made up of large trees of laurel-oak, sweet-gum, red-mulberry, leopard-oak, pignut hickory, basswood, sour-gum, cherry, and other species, exists on the Meridian road one block north of Tharp street. This rich tree association, heavy in shade, has a scant understory of shrubs and a relatively clean forest floor with a typical rich forest soil. Like others approximating the type, this modified hardwood stand displays only a limited number of so-called woodland flowers—*Trillium Underwoodii, Sanguinaria canadensis, Polygonatum biflorum, Uvularia perfoliata, Muricauda Dracontium, Arisaema triphyllum* (in moist situations), *Sanicula canadensis, Spigelia marylandica, Viola Walteri, Mitchella repens* (in the spring), and two orchids, *Hexalectris spicata* and *Tipularia unifolia* (in the summer). These perennials, plus a few more inconspicuous forbs, grasses, sedges, and ferns, make up the modest but interesting herbs of most modified climax-hardwoods.

It is not difficult to find young fire-free hardwood associations with red-mulberry, pignut hickory, sweet-gum, or basswood coming up in the understory. As stated in connection with Perkins woods, a liberal number of magnolia saplings may also be present. The presence of the latter with the other young hardwoods points to a temporary mixed climax and possibly to ultimate dominance of magnolia and beech. However, in some instances a good number of young hardwood species and individuals may be accompanied by only a few scattered magnolia and beech saplings. From such an assemblage and conditions could arise the particular type of modified climax forest considered in the previous paragraph. I have seen one or two examples of young magnolias a foot or two high, filtering into the open understory of an adult association of hardwoods in that manner. Whether or not these instances presage a subsequent full scale invasion of magnolia into old mixed hardwood forests of this type I do not as yet know. Further study of suitable situations having sustained freedom from fire and other interference over a sufficiently long period of years might produce answers; but the possibility of making such a study is dependent upon the existence of an ideal situation that is hardly to be hoped for.

FLORISTIC COMPOSITION OF ASSOCIATIONS AND SUCCESSIONS OF INDIVIDUAL SPECIES

In table 1 the species of the various associations are the ones I have commonly noticed. Although each stand was visited at least three times, further observations would undoubtedly disclose other species that should be added to the list for some particular association or have their ranges extended into adjacent associations. Taking the present data as found, I have arranged the species so that the signs indicating their presence, when read vertically, will show the floristic composition of the different associations. When the signs are read horizontally, the table shows the ecological range of each species in terms of associations, and, in broader view, the successional stage at which each species enters, those through which it persists, and that at which it falls out—really the successional trends or dynamics of the vegetation as a whole.

Reading the table from left to right, the reader familiar with the growth forms of the species concerned will note how the pioneer herbs, shrubs, and trees of the sunny, open, habitats yield to the later more shade-tolerant herbaceous and woody plants. He will observe, too, that in general the perennial pioneer herbs persist for a longer time in the succeeding shade-casting pine or pine—oak—hickory associations than the earliest annuals and biennials; and, moreover, that the very perennials that outlast the latter do in turn yield to a still more shade-tolerant association of herbs found in the mature oak—hickory woods, or in pure climax forest. Similar replacement will be seen on the part of the trees and shrubs. The sun-loving pioneer pines, oaks, and hickories, for example, finally give way to the most shade-tolerant trees, magnolia and beech.

The reader should understand that the last three associations at the extreme right (the pine—deciduous oak—hickory, the evergreen oak—hardwood—pine, and the modified climax-hardwood) are really not in sequence with the group of seven associations to the left. Neither do they represent associations necessarily in sequence with each other, although when undisturbed the pine—deciduous oak—hickory association usually goes into the evergreen oak—hardwood—pine. These two associations, as explained elsewhere, are held in their respective states by prevailing practices of cutting, grazing, and burning. The modified climax-hardwoods, on the other hand, seem to be the result of seriously modified or set-back climax forests. Briefly, columns I to VII represent the beginning and the culmination of the *direct succession;* whereas columns A, B, and C are associations more or less *arrested* or *set back* by major disturbances.

Naturally enough the middle of the table shows much overlap of species and ranging to the left or right. Strikingly different, though, are the species of herbs and woody plants in the pioneer columns at the extreme left from those at the right where the climax forest species are indicated. Some species, because of great adaptability, range across a number of associations—*Andropogon* spp., *Ascyrum stans,* and *Quercus rubra triloba,* for example; others, more specific in their requirements, are restricted to a very limited number of association types — *Tipularia unifolia, Viola Walteri, Trillium Underwoodii, Leptamnium virginianum,* and *Sanguinaria canadensis,* for instance.

TABLE I WITH FLORISTIC COMPOSITION ON FOLLOWING PAGES

TABLE 1.—FLORISTIC COMPOSITION OF ASSOCIATIONS AND SUCCESSIONS OF INDIVIDUAL SPECIES

SCIENTIFIC NAME	COMMON NAME	I	II	III	IV	V	VI	VII	A	B	C
Acalypha gracilens A. Gray	Three-seeded mercury	x	..	..	..	..	..	..	..	..	..
Amaranthus hybridus L.	Pigweed	x	..	..	..	..	..	..	..	..	..
Ambrina ambrosioides (L.) Spach.	Mexican-tea	x	..	..	..	..	..	..	..	..	..
Bidens bipinnata L.	Spanish-needles	x	..	..	..	..	..	..	..	..	..
Chamaesyce hyssopifolia (L.) Small	Eye-bane	x	..	..	..	..	..	..	..	..	..
Cenchrus echinatus L.	Hedgehog-grass	x	..	..	..	..	..	..	..	..	..
Commelina longicaulis Jacq.	Baby-dewflower	x	..	..	..	..	..	..	..	..	..
Eupatorium capillifolium (Lam.) Small	Dog-fennel	x	..	..	..	..	..	..	..	..	..
Lepidium virginicum L.	Pepper-grass	x	..	..	..	..	..	..	..	..	..
Linaria canadensis (L.) Dum.	Blue-toadflax	x	..	..	..	..	..	..	..	..	..
Meibomia purpurea (Mill.) Vail	Florida-beggarweed	x	..	..	..	..	..	..	..	..	..
Passiflora incarnata L.	May-pop	x	..	..	..	..	..	..	..	..	..
Plantago virginica L.	Plantain	x	..	..	..	..	..	..	..	..	..
Poinsettia heterophylla (L.) Small	Painted-leaf	x	..	..	..	..	..	..	..	..	..
Raimannia laciniata (Hill.) Rose	Evening primrose	x	..	..	..	..	..	..	..	..	..
Silene antirrhina L.	Sleepy-catchfly	x	..	..	..	..	..	..	..	..	..
Sitilias caroliniana (Walt.) Raf.	False-dandelion	x	..	..	..	..	..	..	..	..	..
Specularia perfoliata (L.) A.DC.	Venus's looking-glass	x	..	..	..	..	..	..	..	..	..
Spermolepis divaricata (Walt.) Raf.		x	..	..	..	..	..	..	..	..	..
Quamoclit Quamoclit (L.) Britton	Cypress vine	x	..	..	..	..	..	..	..	..	..
Xanthium americanum Walt.	Cocklebur	x	..	..	..	..	..	..	..	..	..
Setaria geniculata (Lam.) Beauv.	Knotroot bristlegrass	x	..	..	..	..	..	..	x	..	..
Leptilon canadense (L.) Britton	Horse-weed	x	x	..	..	..	..	..	..	..	..
Rumex hastatulus Baldw.	Dock	x	x	..	..	..	..	..	..	..	..
Heteropogon melanocarpus (Ell.) Benth.	Sweet tanglehead	x	†	x	..	..	..	..	..	..	..
Oenothera biennis L.	Common evening-primrose	x	x	x	..	..	..	..	..	..	..
Digitaria villosa (Walt.) Pers.	Crabgrass	x	x	x	..	..	..	..	x	..	..

Eragrostis hirsuta (Michx.) Nees	Love-grass	x	x	x	..	..	..	..	x	..	..
Corchorus acutangulus Lam.	Jute	x	†	†	x	..	..	..	..	..	..
Isopappus divaricatus (Nutt.) T.&G.		x	..	..	x	..	..	..	..	..	..
Sarothra gentianoides L.	Pinweed	x	x	x	x	..	..	..	..	..	..
Xanthoxalis Brittoniae Small	Sourgrass	x	x	x	x	..	..	..	..	..	..
Gnaphalium obtusifolium L.	Rabbit-tobacco	x	x	..	..	x	..	x	x	..	..
Erigeron ramosus (Walt.) B.S.P.	Daisy-fleabane	x	x	x	..	x	..	..	..	..	..
Richardia scabra St. Hil.	Mexican-clover	x	x	x	..	x	..	..	..	..	..
Eupatorium compositifolium Walt.	Dog-fennel	x	x	x	..	x	..	..	x	..	..
Ambrosia elatior L.	Ragweed	x	x	x	x	x	..	..	..	..	..
Bignonia radicans L.	Cross-vine	x	x	x	x	x	..	..	..	..	..
Diodella teres (Walt.) Small	Button-weed	x	x	x	x	x	..	..	..	..	..
Emelista Tora (L.) Britton and Rose	Coffee-weed	x	x	x	x	x	..	..	..	..	..
Eragrostis spectabilis (Pursh) Steud.	Purple love-grass	x	x	x	x	x	..	..	..	..	..
Polypremum procumbens L.		x	x	x	x	x	..	..	..	..	..
Rubus cuneifolius Pursh.	Blackberry	x	x	x	x	x	..	..	..	..	..
Rubus trivialis Michx.	Dewberry	x	x	x	x	x	..	..	..	..	..
Andropogon virginicus hirsutior (Hack.) Hitchc.	Broom-sedge	..	x	..	..	..	..	..	..	..	..
Bivonea stimulosa (Michx.) Raf.	Spurge-nettle	..	x	..	..	..	..	..	x	x	..
Cyperus retrorsus Chapm.	Galingale	..	x	x	..	..	..	..	..	..	..
Meibomia ciliaris (Muhl.) Blake	Tick-trefoil	..	x	x	..	..	..	..	x	..	..
Crotalaria rotundifolia (Walt.) Poir.	Rabbit-bells	..	x	x	x	x	..	..	x	..	..
Sassafras Sassafras (L.) Karst.	Sassafras	..	x	..	..	x	x	..	x	..	..
Chamaecrista robusta Pollard	Sensitive-pea	..	x	x	..	x	x	..	..	x	..
Andropogon Cabanisii Hack.	Broom-grass	..	x	x	x	x	x	..	..	x	..
Andropogon virginicus L.	Broom-sedge	..	x	x	x	x	x	..	x	..	..

LEGEND

I	Annuals	IV	Pines	A	Pine—deciduous oak—hickory
II	Biennials	V	Pine—oak—hickory	B	Evergreen oak—hardwoods
III	Perennials	VI	Mature oak—hickory	C	Modified climax-hardwoods
		VII	Magnolia—beech climax		

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† Glaring and improbable gaps like these may merely mean that I happen to have no positive record for these stations in between.

TABLE 1—(Continued)

SCIENTIFIC NAME	COMMON NAME	I	II	III	IV	V	VI	VII	A	B	C
Diospyros virginiana L.	Persimmon	..	x	..	..	x	..	x	..	x	x
Cyperus rotundus L.	Nut-grass	..	x	x	x	x	x	x	..	..	..
Ascyrum hypericoides L.	St. Andrew's-cross	..	x	x	x	x	x	x	x	x	..
Anychiastrum Baldwinii (T.&G.) Small	Whitlow-wort	..	..	x	..	..	..	..	..	..	..
Chamaecrista littoralis Pollard	Sensitive-pea	..	..	x	..	..	..	..	..	..	..
Chamaecrista procumbens (L.) Greene	Sensitive-pea	..	..	x	..	..	..	..	..	..	..
Chamaecrista multipinnata Pollard	Wild sensitive-plant	..	..	x	..	..	..	..	..	..	..
Croton glandulosus septentrionalis Muell. Arg.	Croton	..	..	x	..	..	..	..	..	..	..
Euthamia minor (Michx.) Greene		..	..	x	..	..	..	..	..	..	..
Lechea villosa Ell.	Pinweed	..	..	x	..	..	..	..	..	..	..
Meibomia laevigata (Nutt.) Kuntze	Tick-trefoil	..	..	x	..	..	..	..	..	..	..
Meibomia viridiflora (L.) Kuntze	Tick-trefoil	..	..	x	..	..	..	..	..	..	..
Solidago gracillima T.&G.	Goldenrod	..	..	x	..	..	..	..	..	..	..
Persicaria longistyla Small	Smartweed	..	..	x	..	..	..	..	..	..	..
Asemeia grandiflora (Walt.) Small	Candyweed	..	..	x	..	..	..	..	x	..	..
Axonopus affinis Chase	Carpet-grass	..	..	x	..	..	..	..	x	..	..
Lespedeza virginica (L.) Britton	Bush-clover	..	..	x	..	..	..	..	x	..	..
Sorghastrum nutans (L.) Nash	Wood-grass	..	..	x	..	..	..	..	x	..	..
Triodia flava (L.) Smyth	Sand-grass	..	..	x	..	..	..	..	x	..	..
Lespedeza repens (L.) Bart.	Bush-clover	..	..	x	x	..	..	..	..	..	..
Lespedeza striata (Thunb.) H.&A.	Japanese-clover	..	..	x	x	..	..	..	..	..	..
Galypola incarnata (L.) Nieuwl.	Procession-flower	..	..	x	..	x	..	..	x	..	..
Lespedeza frutescens (L.) Britton	Bush-clover	..	..	x	..	x	x	..	x	..	..
Gnaphalium spathulatum Lam.	Cudweed	..	..	x	x	x	..	..	..	..	..
Andropogon ternarius Michx.	Broom-grass	..	..	x	x	x	..	..	x	..	..
Gymnopogon ambiguus (Michx.) B.S.P.	Beard-grass	..	..	x	x	x	..	..	..	x	..
Aristida purpurascens Poir.	Wire-grass	..	..	x	x	x	x	..	x	..	..

Smilax glauca Walt.	Wild-sarsaparilla	..	..	x	x	x	x	..	x	x	..
Elephantopus tomentosus L.	Elephant-foot	..	..	x	x	x	x	..	x	x	x
Pinus echinata Mill.	Short-leaf pine	..	..	x	x	x	x	..	x	x	x
Cynodon Dactylon (L.) Pers.	Bermuda-grass	..	..	..	x	..	..	..	..	..	..
Agalinus fasciculata (Ell.) Raf.	False-foxglove	..	..	..	x	..	..	..	..	x	..
Rhus Copallinum L.	Dwarf-sumac	..	..	..	x	x	x	..	x	x	x
Carex styloflexa Buckley	Sedge	..	..	..	..	x	..	..	..	..	..
Corallorrhiza Wisteriana Conrad	Coral-root	..	..	..	..	x	x	..	x	x	..
Eryngium synchaetum (A. Gray) Rose	Eryngo	..	..	..	..	x	..	..	..	..	..
Scleria ciliata Michx.	Nut-rush	..	..	..	..	x	..	..	..	..	..
Asclepias tuberosa L.	Butterfly-weed	..	..	..	..	x	..	..	x	..	..
Cracca chrysophylla (Pursh) Kuntze	Hoary-pea	..	..	..	..	x	..	..	x	..	..
Phaethusa virginica (L.) Small	Frost-weed	..	..	..	..	x	..	..	x	..	..
Pityopsis graminifolia (Michx.) Nutt.	Golden-aster	..	..	..	..	x	..	..	x	..	..
Viburnum rufidulum Raf.	Southern black-haw	..	..	..	..	x	..	..	..	x	x
Asimina parviflora (Michx.) Dunal	Small-fruited pawpaw	..	..	..	..	x	..	..	x	x	..
Batodendron arboreum (Marsh.) Nutt.	Sparkleberry	..	..	..	..	x	..	..	x	x	..
Castanea pumila (L.) Mill.	Chinquapin	..	..	..	..	x	..	..	x	x	..
Erythrina herbacea L.	Cardinal-spear	..	..	..	..	x	..	..	x	x	..
Habenaria quinqueseta (Michx.) Sw.	Longspur-orchid	..	..	..	..	x	..	..	x	x	..
Helianthus montanus E. E. Watson	Sunflower	..	..	..	..	x	..	..	x	x	..
Tithymalopsis apocynifolia Small	Euphorbia	..	..	..	..	x	..	..	x	x	..
Nemexia Hugeri Small	Carrion-flower	..	..	..	..	x	..	..	x	x	..
Quercus velutina Lam.	Black-oak	..	..	..	..	x	..	..	x	x	..
Nyssa sylvatica Marsh.	Sour-gum	..	..	..	..	x	..	..	x	x	x
Nintooa japonica (Thunb.) Sweet	Japanese-honeysuckle	..	..	..	..	x	x	..	..	..	..

LEGEND

I Annuals
II Biennials
III Perennials

IV Pines
V Pine—oak—hickory
VI Mature oak—hickory
VII Magnolia—beech climax

A Pine—deciduous oak—hickory
B Evergreen oak—hardwoods
C Modified climax-hardwoods

TABLE 1—(Continued)

SCIENTIFIC NAME	COMMON NAME	I	II	III	IV	V	VI	VII	A	B	C
Agrimonia microcarpa Wallr.	Agrimony	..	..	..	..	x	x	..	x	..	..
Monotropa uniflora L.	Indian-pipe	..	..	..	..	x	x	..	x	..	..
Vernonia altissima Nutt.	Ironweed	..	..	..	..	x	x	..	x	..	..
Viola triloba dilatata Pollard	Violet	..	..	..	..	x	x	..	x	..	..
Eupatorium aromaticum L.	Wild-hoarhound	..	..	..	..	x	x	..	x	x	..
Galium bermudense L.	Bedstraw	..	..	..	..	x	x	..	x	x	..
Houstonia procumbens (Walt.) Standley		..	..	..	..	x	x	..	x	x	..
Padus virginiana (L.) Mill.	Wild black-cherry	..	..	..	..	x	x	..	x	x	..
Sericocarpus bifoliatus (Walt.) Porter	White-topped aster	..	..	..	..	x	x	..	x	x	..
Silphium Asteriscus L.	Rosin-weed	..	..	..	..	x	x	..	x	x	..
Solidago Bootii Hook.	Goldenrod	..	..	..	..	x	x	..	x	x	..
Vitis rufotomentosa Small	Wild-grape	..	..	..	..	x	x	..	x	x	..
Sanicula canadensis L.	Sanicle	..	..	..	..	x	x	..	..	x	..
Asplenium platyneuron (L.) Oakes	Spleenwort fern	..	..	..	..	x	x	..	x	x	x
Cynoxylon floridum (L.) Raf.	Flowering dogwood	..	..	..	..	x	x	..	x	x	x
Hicoria alba (L.) Britton	Mockernut	..	..	..	..	x	x	..	x	x	x
Liquidambar Styraciflua L.	Sweet-gum	..	..	..	..	x	x	..	x	x	x
Quercus laurifolia Michx.	Laurel-oak	..	..	..	..	x	x	..	x	x	x
Quercus nigra L.	Water-oak	..	..	..	..	x	x	..	x	x	x
Quercus rubra triloba (Michx.) Ashe	Red-oak	..	..	..	..	x	x	..	x	x	x
Quercus stellata Wang.	Post-oak	..	..	..	..	x	x	..	x	x	x
Quercus virginiana Mill.	Live-oak	..	..	..	..	x	x	..	x	x	x
Pinus Taeda L.	Loblolly-pine	..	..	..	..	x	x	..	x	x	x
Callicarpa americana L.	French-mulberry	..	..	..	..	x	x	x	x	x	x
Mitchella repens L.	Partridge-berry	..	..	..	..	x	x	x	x	x	x
Muscadinia rotundifolia (Michx.) Small	Muscadine	..	..	..	..	x	x	x	x	x	x
Parthenocissus quinquefolia (L.) Planch.	Virginia-creeper	..	..	..	..	x	x	x	x	x	x
Smilaxa Bona-nox L.	Bamboo	..	..	..	..	x	x	x	x	x	x

Toxicodendron radicans (L.) Kuntze	Poison-ivy	..	..	..	..	x	x	x	x	x	x
Solidago hirsutissima Mill.	Goldenrod	..	..	..	..	x	..	x	..	x	x
Strophostyles umbellata (Muhl.) Britton	Wild-bean	..	..	..	..	..	x	..	x	..	..
Carex floridana Schw.	Sedge	..	..	..	..	..	x	..	x	x	..
Scutellaria Altamaha Small	Skullcap	..	..	..	..	..	x	..	x	x	..
Morus rubra L.	Red-mulberry	..	..	..	..	..	x	..	x	x	x
Smilax lanceolata L.	Jackson brier	..	..	..	..	..	x	..	..	x	x
Magnolia grandiflora L.	Magnolia	..	..	..	..	..	x	x	..	x	x
Fagus grandifolia Ehrh.	Beech	..	..	..	..	..	x	x	..	x	x
Passiflora lutea L.	Yellow passion-flower	..	..	..	..	..	..	x	x	x	..
Aralia spinosa L.	Devil's-walking stick	..	..	..	..	..	..	x	x	x	x
Galium tinctorium L.	Bedstraw	..	..	..	..	..	..	x	x	x	x
Ilex opaca Ait.	Holly	..	..	..	..	..	..	x	x	x	x
Aristolochia Serpentaria L.	Virginia-snakeroot	..	..	..	..	..	..	x	..	x	..
Carex tenax Chapm.	Sedge	..	..	..	..	..	..	x	..	x	..
Anisostichus crucigera (L.) Bureau	Cross-vine	..	..	..	..	..	..	x	..	x	x
Euonymus americanus L.	Strawberry-bush	..	..	..	..	..	..	x	..	x	x
Galium triflorum Michx.	Sweet-scented bedstraw	..	..	..	..	..	..	x	..	x	x
Galium uniflorum Michx.	Bedstraw	..	..	..	..	..	..	x	..	x	x
Halesia diptera Ellis	Silverbell-tree	..	..	..	..	..	..	x	..	x	x
Hicoria glabra (Mill.) Britton	Pignut	..	..	..	..	..	..	x	..	x	x
Oplismenus setarius (Lam.) Roem & Schult.	Wood-grass	..	..	..	..	..	..	x	..	x	x
Ostrya virginiana (Mill.) Willd.	Ironwood	..	..	..	..	..	..	x	..	x	x
Pinus glabra Walt.	Walter's-pine	..	..	..	..	..	..	x	..	x	x
Polystichum acrostichoides (Michx.) Schott	Christmas fern	..	..	..	..	..	..	x	..	x	x
Smilax pumila Walt.	Sarsaparilla-vine	..	..	..	..	..	..	x	..	x	x

LEGEND

I Annuals	IV Pines	A Pine—deciduous oak—hickory
II Biennials	V Pine—oak—hickory	B Evergreen oak—hardwoods
III Perennials	VI Mature oak—hickory	C Modified climax-hardwoods
	VII Magnolia—beech climax	

TABLE 1—(Continued)

SCIENTIFIC NAME	COMMON NAME	I	II	III	IV	V	VI	VII	A	B	C
Trillium Underwoodii Small	Wake-robin	..	..	..	..	..	..	x	..	x	x
Leptamnium virginianum (L.) Raf.	Beech-drops	..	..	..	..	..	..	x	..	..	x
Andropogon Elliottii Chapm.	Broom-grass	..	..	..	..	..	..	..	x	..	..
Andropogon scoparius Michx.	Broom-grass	..	..	..	..	..	..	..	x	..	..
Aristida lanosa Muhl.	Wire-grass	..	..	..	..	..	..	..	x	..	..
Aster gracilipes (Wiegand) Alexander	Aster	..	..	..	..	..	..	..	x	..	..
Aureolaria flava reticulata (Raf.) Pennel	Yellow-foxglove	..	..	..	..	..	..	..	x	..	..
Baptisia psammophila Larisey	False indigo	..	..	..	..	..	..	..	x	..	..
Celtis georgiana Small	Georgia-hackberry	..	..	..	..	..	..	..	x	..	..
Chrysopsis floridana Small	Golden-aster	..	..	..	..	..	..	..	x	..	..
Chrysopsis mariana (L.) Nutt.	Golden-aster	..	..	..	..	..	..	..	x	..	..
Cracca latidens Small	Hoary-pea	..	..	..	..	..	..	..	x	..	..
Cracca virginiana L.	Cat-gut	..	..	..	..	..	..	..	x	..	..
Erianthus alopecuroides (L.) Ell.	Woolly beard-grass	..	..	..	..	..	..	..	x	..	..
Eupatorium album L.		..	..	..	..	..	..	..	x	..	..
Eupatorium incarnatum Walt.		..	..	..	..	..	..	..	x	..	..
Eupatorium jucundum Greene		..	..	..	..	..	..	..	x	..	..
Eupatorium lecheaefolium Greene		..	..	..	..	..	..	..	x	..	..
Eupatorium rotundifolium L.	False-hoarhound	..	..	..	..	..	..	..	x	..	..
Galactia floridana T.&G.	Milk-pea	..	..	..	..	..	..	..	x	..	..
Galactia volubilis (L.) Britton	Milk-pea	..	..	..	..	..	..	..	x	..	..
Galium pilosum Ait.	Bedstraw	..	..	..	..	..	..	..	x	..	..
Hieracium Gronovii L.	Hawkweed	..	..	..	..	..	..	..	x	..	..
Kuhnia Mosieri Small	False-boneset	..	..	..	..	..	..	..	x	..	..
Laciniaria spicata (L.) Kuntze	Blazing-star	..	..	..	..	..	..	..	x	..	..
Leptoglottis floridana (Chapm.) Small	Sensitive-briar	..	..	..	..	..	..	..	x	..	..
Lespedeza hirta (L.) Ell.	Bush-clover	..	..	..	..	..	..	..	x	..	..
Lobelia puberula Michx.	Lobelia	..	..	..	..	..	..	..	x	..	..

Martiusia mariana (L.) Small	Butterfly-pea	..	..	..	..	..	..	..	x	..	..
Meibomia arenicola Vail	Tick-trefoil	..	..	..	..	..	..	..	x	..	..
Meibomia Chapmanii (Britton) Small	Tick-trefoil	..	..	..	..	..	..	..	x	..	..
Meibomia rhombifolia (Ell.) Vail	Tick-trefoil	..	..	..	..	..	..	..	x	..	..
Monarda punctata L.	Horse-mint	..	..	..	..	..	..	..	x	..	..
Phlox pilosa L.	Downy-phlox	..	..	..	..	..	..	..	x	..	..
Pityopsis microcephala Small	Golden-aster	..	..	..	..	..	..	..	x	..	..
Pterophyton aristatum (Ell.) Alexander		..	..	..	..	..	..	..	x	..	..
Quercus marilandica Muench.	Black-jack oak	..	..	..	..	..	..	..	x	..	..
Rudbeckia hirta L.	Yellow-daisy	..	..	..	..	..	..	..	x	..	..
Sorghastrum secundum (Ell.) Nash	Indian-grass	..	..	..	..	..	..	..	x	..	..
Solidago odora Ait.	Sweet-goldenrod	..	..	..	..	..	..	..	x	..	..
Sporobolus gracilis (Trin.) Merr.	Dropseed grass	..	..	..	..	..	..	..	x	..	..
Trichostema dichotomum L.	Bastard-pennyroyal	..	..	..	..	..	..	..	x	..	..
Amarolea americana (L.) Small	Wild-olive	..	..	..	..	..	..	..	x	x	..
Angelica dentata (Chapm.) Coult. & Rose	Angelica	..	..	..	..	..	..	..	x	x	..
Asclepias verticillata L.	Milkweed	..	..	..	..	..	..	..	x	x	..
Biventraria variegata (L.) Small	Milkweed	..	..	..	..	..	..	..	x	x	..
Bradburya virginiana (L.) Kuntze	Butterfly-pea	..	..	..	..	..	..	..	x	x	..
Ceanothus americanus L.	New Jersey tea	..	..	..	..	..	..	..	x	x	..
Dyschoriste oblongifolia (Michx.) Kuntze		..	..	..	..	..	..	..	x	x	..
Laurocerasus caroliniana (Mill.) Roem.	Wild cherry-laurel	..	..	..	..	..	..	..	x	x	..
Manfreda virginica (L.) Salisb.	Rattlesnake-master	..	..	..	..	..	..	..	x	x	..
Melanthera hastata Michx.		..	..	..	..	..	..	..	x	x	..
Meibomia nudiflora (L.) Kuntze	Tick-trefoil	..	..	..	..	..	..	..	x	x	..

LEGEND

I Annuals
II Biennials
III Perennials

IV Pines
V Pine—oak—hickory
VI Mature oak—hickory
VII Magnolia—beech climax

A Pine—deciduous oak—hickory
B Evergreen oak—hardwoods
C Modified climax-hardwoods

TABLE 1—(Continued)

SCIENTIFIC NAME	COMMON NAME	I	II	III	IV	V	VI	VII	A	B	C
Phoebanthus grandiflora (T.&G.) Blake		..	..	..	..	..	..	..	x	x	..
Rosa serrulata Raf.	Wild rose	..	..	..	..	..	..	..	x	x	..
Ruellia hybrida Pursh.		..	..	..	..	..	..	..	x	x	..
Salvia azurea Lam.	Sage	..	..	..	..	..	..	..	x	x	..
Scutellaria integrifolia L.	Skullcap	..	..	..	..	..	..	..	x	x	..
Smilax auriculata Walt.	Wild-bamboo	..	..	..	..	..	..	..	x	x	..
Sporobolus Poiretii (Roem. and Schult.) Hitchc.	Drop-seed grass	..	..	..	..	..	..	..	x	x	..
Vernonia ovalifolia T.&G.	Ironweed	..	..	..	..	..	..	..	x	x	..
Pteris latiuscula Desv.	Bracken fern	..	..	..	..	..	..	..	x	..	x
Sanicula floridana Bicknell	Snake-root	..	..	..	..	..	..	..	x	..	x
Phenianthus sempervirens (L.) Raff.	Trumpet-honeysuckle	..	..	..	..	..	..	..	x	x	x
Phryma leptostachya L.	Lopseed	..	..	..	..	..	..	..	x	x	x
Quercus Shumardii Buckl.	Leopard-oak	..	..	..	..	..	..	..	x	x	x
Sanguinaria canadensis L.	Blood-root	..	..	..	..	..	..	..	x	x	x
Vernonia angustifolia Michx.	Ironweed	..	..	..	..	..	..	..	x	x	x
Aesculus Pavia L.	Buckeye	..	..	..	..	..	..	..	..	x	..
Arisaema triphyllum (L.) Torr.	Jack-in-the-pulpit	..	..	..	..	..	..	..	..	x	..
Chionanthus virginica L.	Fringe-tree	..	..	..	..	..	..	..	..	x	..
Collinsonia canadensis L.	Horse-balm	..	..	..	..	..	..	..	..	x	..
Conoclinium coelestinum (L.) DC.	Mist-flower	..	..	..	..	..	..	..	..	x	..
Elephantopus carolinianus Willd.	Elephant-foot	..	..	..	..	..	..	..	..	x	..
Galium circaezans Michx.	Wild liquorice	..	..	..	..	..	..	..	..	x	..
Hexalectris spicata (Walt.) Barnhart	Brunetta orchid	..	..	..	..	..	..	..	..	x	..
Ilex ambigua (Michx.) Chapm.	Holly	..	..	..	..	..	..	..	..	x	..
Ilex vomitoria Ait.	Yaupon	..	..	..	..	..	..	..	..	x	..
Malus angustifolia (Ait.) Michx.	Wild crab-apple	..	..	..	..	..	..	..	..	x	..
Muricauda Dracontium (L.) Small	Green-dragon	..	..	..	..	..	..	..	..	x	..

Parthenium integrifolium L.		..	..	..	..	..	..	..	..	x	..
Polygonatum biflorum (Walt.) Ell.	Solomon's-seal	..	..	..	..	..	..	..	..	x	..
Smallanthus Uvedalia (L.) Mackenzie	Bear-foot	..	..	..	..	..	..	..	..	x	..
Smilax hispida Muhl.	Hagbrier	..	..	..	..	..	..	..	..	x	..
Tilia caroliniana Mill.	Basswood	..	..	..	..	..	..	..	..	x	..
Tipularia unifolia (Muhl.) B.S.P.	Cranefly-orchid	..	..	..	..	..	..	..	..	x	..
Uniola sessiliflora Poir.	Spike-grass	..	..	..	..	..	..	..	..	x	..
Uvularia perfoliata L.	Straw-bell	..	..	..	..	..	..	..	..	x	..
Vernonia gigantea (Walt.) Trelease	Ironweed	..	..	..	..	..	..	..	..	x	..
Viburnum semitomentosum (Michx.) Rehder	Arrow-wood	..	..	..	..	..	..	..	..	x	..
Arundinaria tecta (Walt.) Muhl.	Small-cane	..	..	..	..	..	..	..	..	x	x
Botrychium alabamense Maxon	Moonwort fern	..	..	..	..	..	..	..	..	x	x
Carpinus caroliniana Walt.	Hornbeam	..	..	..	..	..	..	..	..	x	x
Cercis canadensis L.	Red-bud	..	..	..	..	..	..	..	..	x	x
Crataegus uniflora Muench.	Dwarf-thorn	..	..	..	..	..	..	..	..	x	x
Cyperus globulosus Aubl.	Galingale	..	..	..	..	..	..	..	..	x	x
Fraxinus americana L.	White-ash	..	..	..	..	..	..	..	..	x	x
Galium pilosum laevicaule	Bedstraw	..	..	..	..	..	..	..	..	x	x
Hicoria austrina Small	Hickory	..	..	..	..	..	..	..	..	x	x
Hicoria glabra megacarpa (Sarg.) Sudw.	Hickory	..	..	..	..	..	..	..	..	x	x
Hicoria microcarpa (Nutt.) Britton	Small-pignut	..	..	..	..	..	..	..	..	x	x
Osmundopteris virginiana (L.) Small	Rattlesnake-fern	..	..	..	..	..	..	..	..	x	x
Quercus alba L.	White-oak	..	..	..	..	..	..	..	..	x	x
Quercus Prinus L.	Cow-oak	..	..	..	..	..	..	..	..	x	x
Rufacer rubrum (L.) Small	Red-maple	..	..	..	..	..	..	..	..	x	x
Symplocos tinctoria (L.) L'Her.	Sweetleaf	..	..	..	..	..	..	..	..	x	x

LEGEND

I Annuals
II Biennials
III Perennials

IV Pines
V Pine—oak—hickory
VI Mature oak—hickory
VII Magnolia—beech climax

A Pine—deciduous oak—hickory
B Evergreen oak—hardwoods
C Modified climax-hardwoods

TABLE 1—(Continued)

SCIENTIFIC NAME	COMMON NAME	I	II	III	IV	V	VI	VII	A	B	C
Tilia georgiana Sarg.	Basswood	..	..	..	..	..	..	..	..	x	x
Tilia heterophylla Vent.	Basswood	..	..	..	..	..	..	..	..	x	x
Viola Walteri House	Violet	..	..	..	..	..	..	..	..	x	x
Conopholis americana (L.f.) Wallr.	Cancer-root	..	..	..	..	..	..	..	..	..	x
Cyperus compressus L.	Galingale	..	..	..	..	..	..	..	..	..	x
Eupatorium trifoliatum L.	Joe-pye-weed	..	..	..	..	..	..	..	..	..	x
Kyllinga odorata Vahl.		..	..	..	..	..	..	..	..	..	x
Muhlenbergia Schreberi Gmel.	Nimble-will	..	..	..	..	..	..	..	..	..	x
Phytolacca americana L.	Poke	..	..	..	..	..	..	..	..	..	x
Sambucus canadensis L.	Common-elder	..	..	..	..	..	..	..	..	..	x
Stenophyllus barbatus (Rottb.) Britton	Water-grass	..	..	..	..	..	..	..	..	..	x
Tamala Borbonia (L.) Raf.	Red-bay	..	..	..	..	..	..	..	..	..	x

LEGEND

I Annuals
II Biennials
III Perennials

IV Pines
V Pine—oak—hickory
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Succession of Panicum Species

By concentrating on different groups of species within a genus or family (*Panicum, Andropogon, Quercus, Compositae* or *Leguminosae,* for examples) or even on growth forms (grasses, forbs, annuals, biennials, perennials, trees, or shrubs) the student will find that the table reveals some interesting tendencies and relations. Following this suggestion I have treated separately the many species of *Panicum* (Table 2). One sees at a glance that *P. aciculare* and *P. arenicoloides* are the first to appear, the former coming soon after the broom-sedges. Then follow additional species into the later dog-fennel—broom-sedge associations, these ranging into the pine—oak—hickory stage. The species persisting from dog-fennel—broom-sedge, together with still more *Panicum* species rather partial to pine—oak—hickory result in considerable bunching at this stage. If through disturbance the woods develop into

Table 2.—Succession of Panicum Species

Scientific Name	I	II	III	IV	V	VI	VII	A	B	C
Panicum aciculare Desv.	..	x	x	x	x	..	..	x	..	..
P. arenicoloides Ashe	..	..	x	x	x	..	..	..	..	..
P. lanuginosum Ell.	..	..	x	x	x	..	..	x	..	..
P. angustifolium Ell.	..	..	x	x	x	x	..	x	..	..
P. oligosanthes Schult.	..	..	x	x	x	x	..	x	..	..
P. xalapense H.B.K.	..	..	x	x	x	x	..	x	x	x
P. villosissimum Nash.	..	..	..	x	x	x	..	x	..	..
P. Boscii molle (Vasey) Hitchc. and Chase	..	..	..	x	x	x	..	x	x	x
P. ovale Ell.	..	..	..	..	x	..	..	..	..	..
P. Lindheimeri Nash	..	..	..	..	x	..	..	..	x	..
P. ciliatum Ell.	..	..	..	..	x	..	..	..	..	..
P. chrysopsidifolium Nash	..	..	..	..	x	..	..	x	..	..
P. sphaerocarpon Ell.	..	..	..	..	x	..	..	x	..	..
P. Boscii Poir.	..	..	..	..	x	..	..	x	x	x
P. mutabile Scribn. & Smith	..	..	..	..	x	x	..	..	x	..
P. commutatum Schult.	..	..	..	..	x	x	..	..	x	x
P. Joorii Vasey	..	..	..	..	..	..	x	..	x	..
P. Ashei Pearson	..	..	..	..	..	..	..	x	..	..
P. Commonsianum Ashe	..	..	..	..	..	..	..	x	..	..
P. rhizomatum Hitchc. and Chase	..	..	..	..	..	..	..	x	..	..
P. albomarginatum Nash	..	..	..	..	..	..	..	..	x	..

Legend

I	Annuals	IV	Pines	A	Pine—deciduous oak—hickory
II	Biennials	V	Pine—oak—hickory	B	Evergreen oak—hardwoods
III	Perennials	VI	Mature oak—hickory	C	Modified climax-hardwoods
		VII	Magnolia—beech climax		

an open pine—deciduous oak—hickory association the number of *Panicum* species reaches a maximum. If, on the other hand, there is little or no molestation and the young pine—oak—hickory which ordinarily follows the broom-sedge—dog-fennel grows rapidly into a shady forest, the *Panicums* of the open habitats disappear. Only a few species may now be found, *Panicum villosissimum* being the common one. By the time the climax is reached the species are reduced to one or to none. The only rather large tract of undisturbed beech—magnolia climax studied (Dr. George Gwynn property, five miles west of Tallahassee on Federal Highway 90) showed rather consistently only *Panicum Joorii.*

To summarize, we find within the genus *Panicum* marked habitat preferences; one or two species are extremely early pioneers in recent fields, many occur in disturbed or mixed woods of various types, and only very few species are found in shady pine groves or in a representative magnolia—beech climax. More investigations may well necessitate modifications in the table. In any event it is hoped that the data thus marshalled may serve as a basis for future studies.

SUMMARY

1. In unburned situations of the Tallahassee red hills secondary succession proceeds rather rapidly through five associations or stages: (1) the annual—biennial ruderal, (2) perennial dog-fennel—broom-sedge, (3) the short-leaf pine, (4) pine—oak—hickory, and (5) the final magnolia—beech climax.

2. The dense short-leaf pine association often open as to trees follows dog-fennel—broom-sedge associations where fires are absent or not too severe. Its species are few.

3. The open pine—deciduous oak—hickory association is caused by fire, grazing, cutting, and other disturbance. It is rich in species of grasses and forbs. Cessation of burning means termination of this association.

4. Magnolia appears early in unburned or generally undisturbed pine or pine—deciduous oak—hickory woods.

5. Magnolia, beech, laurel-oak, water-oak, and even sweet-gum are excluded indefinitely in periodically burned pine or pine—deciduous oak—hickory woods.

6. Post-oak and black-oak, apparently fire opportunists, appear in abundance in the very pine—deciduous oak—hickory woods where yearly fires and a thick ground cover exclude laurel-oak, water-oak, sweet-gum, and magnolia.

7. With reference to oaks it must be emphasized that red-oak, coming in early under pines, persists, fire or no fire; that laurel-oak especially, and water-oak to a degree, are set back or excluded by fires; and that post-oak and black-oak, appearing after red-oak, succeed in burned situations inimical to laurel-and water-oaks, and to young magnolias.

8. Sapling magnolias occur frequently in young oak—hardwood forests or thickets which are characterized by a relatively clean unburned forest floor, rich in leaf mold or pine needle mulch.

9. There is almost universal absence of young magnolias in the shade of mature parent trees, indicating that a magnolia climax does not perpetuate itself by starting its offspring in place. This lack of perpetuation *in situ* is very noteworthy, since reproduction is given as one of the distinguishing characters of the beech—sugar maple climax forests of the North. In modified climax-hardwood stands marked by large trees, dense shade, and clean floor there is the same paucity of magnolia invasion or reproduction. Magnolia and beech invasion seems most frequent in unburned pine or pine—deciduous oak—hickory or in evergreen oak—hardwoods where trees are small, leaf mold abundant, and floor not crowded with herbs, vines, or sprouts. Beech invasion, however, is not as early as magnolia, not appearing, for example, in unburned young pine stands.

10. The initial and end stages of the typical secondary succession display very different combinations of herbs. First come the annuals and biennials in full sun; then the perennial herbs also fully exposed; next perennial herbs typical of the shade of pines or pine—deciduous oak—hickory; and last the meager deep-shade flora of the climax. Like the arboreal associations, the grasses and forbs follow a definite order of succession, typical communities paralleling the successive tree associations.

11. *Panicum,* a large genus of grasses, is represented by approximately twenty common species in the successions. Typically *Panicum arenicoloides* and *P. aciculare* appear in the dog-fennel—broom-sedge stage; *P. angustifolium, P. lanuginosum, P. xalapense,* and *P. villosissimum* in the pines or open pine—deciduous oak—hickory; *P. Boscii* and relics of the previous stage are often present in evergreen oak—hardwoods or in modified climax-hardwoods. And *P. Joorii* is the usual one left in the climax. There is a pronounced bunching of species in the various types or gradations of pine—deciduous oak—hickory associations.

12. Evergreen oak—hardwoods develop from pine—deciduous oak—hickory associations if and when fire is banned.

13. Of the commoner trees of the modified climax-hardwoods, pignut hickory seems to have the most restricted ecological range, for though it is the last species to yield to magnolia, it appears much later than sweet-gum, laurel-oak, and water-oak, also members of the modified climax-hardwoods.

14. If the understory and ground floor are relatively clean, rich in mulch, and not too shady, the modified climax-hardwood forests are characterized by a typical though sparse assemblage of spring and summer woodland flowers and ferns.

A BARK CHARACTER FOR THE IDENTIFICATION OF CERTAIN FLORIDA PINES

Wilbur B. De Vall
United States Forest Service

The purpose of this paper is to describe a hitherto unused taxonomic character present in the bark of certain Florida pines, which taken in connection with other year-round needle and cone characteristics, makes identification of these species easy and certain at any time.

The distribution of this bark character has been studied in all the pines found in the southeastern United States, but only those species native to Florida are here treated. These are (1) longleaf pine (*Pinus australis* Michx. f.), (2) swamp pine (*Pinus palustris* Mill.), (3) shortleaf pine (*Pinus echinata* Mill.), (4) loblolly pine *(Pinus Taeda* L.), (5) slash pine (*Pinus caribaea* Mor.), (6) pond pine (*Pinus serotina* Michx.), (7) spruce pine (*Pinus glabra* Walt.), (8) sand pine (*Pinus clausa* Englm.).

Bark samples were taken from these and other species over a wide area, extending from Florida through Georgia, Tennessee and North Carolina. Numerous samples were obtained from each species from many localities within this territory.

The discussion which follows requires an elementary knowledge of the structure and mode of formation of tree bark. The surface of the tip of a young stem is covered only by a thin epidermis, but this is soon replaced by true bark. Beneath the epidermis there forms a layer known as the periderm, of which the essential part is a sheet of cells called the cork cambium or *phellogen*[1].

By rapid cell division the phellogen gives rise on the outside to layers of dead, hollow, cork-walled cells that constitute the *phellem* or cork layer, and on the inside to thinner-walled living cells, the phelloderm. In some plants the original periderm persists for long periods, or even during the entire life of the plant; but in most trees as the stem enlarges new layers of periderm form beneath the earlier ones. The phellogen of each such zone soon produces its corky phellem layer, which, being impermeable, cuts off all tissues outside from access to food and water. The cells of all layers outside of the innermost and most recent phellem layer are therefore a part of the lifeless outer bark of the tree. In many trees this dead outer bark scales off rapidly and only a thin covering is present at any one time; but in trees like pines it clings for some time and the bark attains some thickness, splitting with the radial growth of the tree into plates or scales with their long axes parallel to the axis of the trunk.

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[1] Entirely distinct from the vascular cambium, which lies deeper within the stem, giving rise on the inside to xylem or wood, and on the outside to the phloem or food-carrying tissues that make up the innermost portions of the "bark."

On account of the method of formation described above, the outer bark of a pine comes to consist of alternating layers of phellem, brownish in color, and of dead phellogen cells. It is the phellogen layers that are of use in identification, for in one group of species they are ivory-white and contrast strongly with the brown phellem layers, while in a second group of species they are relatively inconspicuous and at most slate-gray in color. They are best seen by cutting longitudinally through the outer bark to the depth of the fissures, especially if the cut is made oblique to the radial plane. An axe cut will serve, but use of a knife is preferable.

The Florida species having ivory-white, conspicuous phellogen lines are: *Pinus australis, P. palustris, P. echinata, P. caribaea, P. glabra,* and *P. clausa.* In the remaining two species (*P. Taeda* and *P. serotina*) the lines are inconspicuous or at most slate-gray in color.

This bark character has been tried out over a period of three years in a course in Dendrology given by the author at the University of Florida. It has proven particularly useful in the Gainesville area for separating loblolly pine from swamp pine when other characters failed. An incident that occurred in the course of a timber cruise on the University of Florida Conservation Reserve at Welaka illustrates the field value of the character. Data were being recorded by species, and several pines were encountered in the jungle-like mass of vines and hardwoods so thick that the tops could not be seen. A knife cut through the outer bark sufficed, with what was known as to the species occurring in that area, to make the identification certain. On another occasion a core taken with an increment borer from a tree with a turpentine "face" showed by its bark section that the tree was actually a pond pine and not a swamp pine as one would naturally suppose.

The phellogen lines are not in themselves sufficient for species identification, and the character finds its most useful application as an aid to other means of recognition and in areas where the distribution by species is known, so that some species can be eliminated from consideration.

KEY TO THE SPECIES OF NATIVE FLORIDA PINES

1. Fascicle sheath more than one-half inch in length on year-old needles .... *Pinus australis* (Longleaf pine)

1′. Fascicle sheath less than one-half inch in length on year-old needles 2

2. (1′). Needles more than four inches long 3

2′. Needles less than four inches long 6

3. (2). Phellogen lines conspicuous, ivory-white 4

3′. Phellogen lines inconspicuous, or slate-gray 5

4. (3). Resin canals of the needle two or three, as shown by the number of resin droplets visible with hand lens on cut surface of cross-section made with razor or sharp knife .... *Pinus palustris* (Swamp pine)

4′. Resin canals four to nine (average seven) in cross section of needle .... *Pinus caribaea* (Slash pine)

5. (3′). Cones cylindrical, scales armed with long sharp prickles .... *Pinus Taeda* (Loblolly pine)

5′. Cones ovoid, scales armed with short, sharp prickles .... *Pinus Serotina* (pond pine)

6. (2′). Needles two or three per fascicle; stem of new-growth twigs
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6′. Needles two per fascicle, twigs not glaucous 7

7. (6′). Tree normally growing in mixture with hardwoods; needles flexible and twisted .... *Pinus glabra* (Spruce pine)

7′. Tree normally growing on dunes and dry sandy soil; needles stout, only occasionally twisted .... *Pinus clausa* (Sand pine)

A STATION FOR *RHODODENDRON CHAPMANII* IN EASTERN FLORIDA

HENRY R. TOTTEN, MAJOR, F. A.
University of North Carolina

Rhododendron Chapmanii A. Gray is herewith reported as growing in Camp Blanding, Clay County, Florida. Over sixty clumps have been counted growing along a sandy bluff of the branch of Black Creek that drains Kingsley Lake. The plants are now in two groups, with about two hundred yards between the two groups. Considerable engineering work for drainage and bank control, including a large fill, will account for the separation of the two groups.

Rhododendron Chapmanii has been credited in the literature to low pine woods of West Florida. This station is distinctly East Florida, and is less than forty miles from the Atlantic Coast.

The plants reported for the new station were first observed in flower on March 17, 1942. Flowering continued into April. Kodachrome transparencies were made, and specimens of flowering branches have been deposited in the Herbarium of the University of North Carolina.

Rhododendron clumps in this station are associated with Sand- or Spruce-pine (*Pinus clausa*), Saw-palmetto (*Serenoa repens*), Wild-bamboo (*Smilax auriculata*), Sarsaparilla-vine (*Smilax pumila*), Scrub-oak (*Quercus myrtifolia*), Twin live-oak (*Quercus geminata* = *Q. virginiana var. geminata*), Chapman's-oak (*Quercus Chapmanii*), Red-bay (*Persea Borbonia*), Black-titi (*Cyrilla racemiflora*), American-holly (*Ilex opaca*), Gallberry (*Ilex glabra*), Wild-olive (*Amarolea americana*), Stagger-bushes (*Xolisma ferruginea* and *Xolisma fruticosa*), Dwarf-huckleberry (*Cyanococcus Myrsinites*) and Muscadine (*Muscadinia rotundifolia*).

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NEW FLORIDA FUNGI

William A. Murrill

University of Florida

This is a continuation of my reports on the fungi of the state which have appeared in the "Torrey Bulletin," "Mycologia," "Lloydia" and elsewhere. The fleshy fungi must be studied while they are fresh. Many of our finest and most distinctive species develop during the summer rains. It was not until I became an all-year resident of Florida that I realized the richness and novelty of her fungous flora. Several hundred new species have already been discovered and others are still to be found. Among these are many edible varieties. Some of our most destructive tree diseases also belong to this group. The scientific names here used correspond to those used by me in "North America Flora." For those more familiar with Saccardo's nomenclature I have appended a list of equivalents. All the specimens cited are in the herbarium of the Florida Agricultural Experiment Station at Gainesville.

Clitocybe alachuana sp. nov.

Pileo convexo-depresso, avellaneo, 6 cm. lato, felleo; lamellis angustatis, albis, sporis globosis, 4 μ; stipite albo, tomentoso, 2 × 0.8 cm.

Pileus convex to depressed, irregular, solitary, about 6 cm. broad; surface dry, uneven, subglabrous, margin incurved, even, lobed; context very thin, white, unchanging, very bitter at once; lamellae decurrent, unusually narrow, close, some forked halfway, entire, white, pale yellowish when dry; spores globose, smooth, hyaline, uninucleate, about 4 μ; stipe equal, white, tomentose, especially at the base, 2 × 0.8 cm.

Type collected by West, Arnold and Murrill on dead leaves in Prairie Creek Hammock, July 15, 1938 *(F 17903)*. A very bitter species with grayish cap and close, narrow gills.

Clitocybe concaviformis sp. nov.

Pileo convexo, nigro, subglabro, 1 cm. lato; lamellis praedecurrentibus, praedistantibus, albis; sporis globosis, 4 μ; stipite glabro, albo, 2 cm. longo.

Pileus convex, slightly depressed, solitary, 1 cm. broad; surface dry, subglabrous, opaque, smooth, uniformly black, margin even, entire; context thin, pallid, unchanging; lamellae long-decurrent, very distant, rather broad, arcuate, inserted, entire, white; spores globose or subglobose, smooth, hyaline, 1-guttulate, about 4 μ; stipe subequal, smooth, glabrous, white, about 2 × 0.25 cm.

Type collected by West, Arnold and Murrill on an oak log in Planera Hammock, eleven miles northwest of Gainesville, Fla., July 16, 1938 *(F 17889)*. About as black above as a mushroom ever gets, and white all below. Apparently very rare in this region.

Clitocybe luteiceps sp. nov.

Pileo convexo-plano, 8 cm. lato, glabro, luteo, substriato, anisato, grato; lamellis subdecurrentibus, angustatis, confertis, luteiflavis; sporis ovoideis, 7-8 × 4-5 μ; stipite concolori, 2 × 1.5-2 cm.

Pileus convex to plane with a slight central depression, 8 cm. broad; surface moist, dull, smooth, glabrous, uniformly luteous, margin subundulate, slightly striate over the lamellae, fertile, straight at maturity, concolorous; context thin, dull-yellowish, unchanging, with anise odor and mild taste; lamellae pallid, inserted, crowded, narrow, broadest behind and slightly decurrent, edges entire and luteiflavous; spores ovoid or ellipsoid, smooth, hyaline, 1-guttulate, about 7-8 × 4-5 μ; cystidia none; stipe short, strongly tapering downward, slightly roughened with short ridges and pits, dull, luteous, 2 × 1.5-2 cm.

Type collected by W. A. Murrill in leaf-mold under a laurel oak in a virgin high hammock at Gainesville, Fla., Oct. 9, 1943 *(F 20029).* A beautiful species, unusual in color both on the cap and on the edges of the gills. On drying the cap becomes shining reddish-fulvous, while the stem does not change. At first sight I thought of *Flammula.*

Clitocybe Rappiana sp. nov.

Pileo convexo-expanso, 5 - 8 cm. lato, pruinoso, latericio; lamellis albis, abundantibus, sporis ovoideis, 3-4 × 2.5-3 μ; stipite albo, 4-5 × 0.5-0.7 cm.

Pileus convex to expanded, gregarious, 5 - 8 cm. broad; surface dry, minutely tomentose, not becoming glabrous, uniformly lateritious or with a small bay disk; margin even, subentire, fertile, uplifted in age; context thick, milk-white, unchanging, reddish under the cuticle, odor slightly farinaceous, taste somewhat farinaceous, becoming slightly astringent, scarcely bitter; lamellae short-decurrent, arcuate, narrow, exceedingly close, 3 to a mm., several times inserted, many forked near the base, entire, pure-white, unchanging, stramineous when dried; spores broadly ovoid, smooth, hyaline, uniguttulate, 3-4 × 2.5-3 μ; cystidia none; stipe curved, equal, glabrous, milk-white, unchanging, 4-5 × 0.5-0.7 cm.

Type collected by W. A. Murrill on the ground under hardwood trees in a high hammock near Hunter's Station, west of Gainesville, Fla., August 10, 1938 *(F 18028).* A very beautiful species, suggesting *C. inversa* (Scop.) Quél. but having white flesh and white, unchanging gills. Mr. S. Rapp, of Sanford, Fla., was with us, collecting lichens, so I named this handsome novelty in his honor.

Clitocybe submedia sp. nov.

Pileo infundibuliformi, 4.5 cm. lato, glabro, striato, avellaneo, disco fuligineo; lamellis distantibus, pallidis; sporis globosis, 5 μ; stipite glabro, avellaneo, 3 × 0.4 cm.

Pileus infundibuliform, solitary, 4.5 cm. broad; surface dry, glabrous, avellaneous, fuliginous at the center, margin widely striate and split; context very thin, pallid, odorless; lamellae short-decurrent, inserted, distant, medium broad, pallid, entire; spores globose, smooth, hyaline, about 5 μ; cystidia none; stipe equal, smooth, glabrous, avellaneous, white at the apex, 3 × 0.4 cm.

Type collected by W. A. Murrill on the ground in Planera Hammock, eleven miles northwest of Gainesville, Fla., Aug. 2, 1938 *(F 19328)*. Not found elsewhere. Suggesting *C. media* Pk. in color but smaller and having very different spores.

Geopetalum alachuanum sp. nov.

Pileo subcirculari, 1.5 cm. lato, glabro, avellaneo; lamellis angustatis, confertis, albis; sporis ellipsoideis, 6 × 4 μ; cystidiis hyalinis, 35 × 15 μ; stipite laterali, tuberculari, albo, pruinoso.

Pileus subcircular, slightly depressed, solitary, 1.5 cm. broad; surface smooth, glabrous, shining, uniformly dark-avellaneous with an isabelline tint, margin deflexed, even, entire; context thin, white, odorless; lamellae decurrent, inserted, very narrow, crowded, white, unchanging, denticulate; spores ellipsoid, smooth, hyaline, about 6 × 4 μ; cystidia abundant, tapering from a broad base to a sharp point, smooth, hyaline, projecting about 35 × 15 μ; stipe lateral, very short, white, pruinose.

Type collected by W. A. Murrill on dead frondose wood at Newnan's Lake, Alachua Co., Fla., July 9, 1938 *(F 19357)*. Not found elsewhere.

Gymnopus amarus sp. nov.

Pileo conico-convexo, 2 cm. lato, avellaneo, amaro; sporis ellipsoideis, 5 - 6 × 3 - 4 μ; stipite albo, 3 × 0.3 - 0.6 cm.

Pileus conic-convex, not expanding, cespitose, 2 cm. broad; surface dry, smooth, glabrous, avellaneous, the disk tinged with isabelline, margin even, entire, inflexed; context thin, gray, opaque, bitter at once, odorless; lamellae adnate, inserted, narrow, close, white, unchanging, entire to eroded; spores ellipsoid, smooth, hyaline, uniguttulate, 5 - 6 × 3 - 4 μ; stipe tapering upward, smooth, glabrous, white, 3 × 0.3 - 0.6 cm.

Type collected by West and Murrill on a much-decayed pine log in Sugarfoot Hammock, near Gainesville, Fla., August 4, 1938 *(F 17336)*. Gray above and white below, with bitter flesh.

Gymnopus praemultifolius sp. nov.

Pileo convexo-subexpanso, imbricato, 3.5-4.5 cm. lato, pallide lividocastaneo, amaro; lamellis adnatis, superabundantibus, sporis subglobosis, 1.5-2 μ; stipite excentrico, pallido, 2-5 × 0.2-0.5 cm.

Pileus elliptic or circular, convex to subexpanded, slightly depressed or umbilicate at times, densely imbricate, 3.5-4.5 cm. broad; surface smooth, hygrophanous, glabrous in front, whitish-pruinose behind, pale livid-chestnut; margin incurved, even, lobed at times; context very thin, dull-whitish, fragrant like anise, bitter at once; lamellae emarginate-adnate, inserted, some forked, arcuate, narrow, remarkably crowded, avellaneous, isabelline with age or on drying, edges entire; spores subglobose, smooth, hyaline, uniguttulate, 1.5-2 μ; stipe eccentric, subequal, pruinose, spongy-stuffed, pale yellowish-white, 2-5 × 0.2-0.5 cm.

Type collected by W. A. Murrill on a rotten hardwood log in the shade, at Gainesville, Fla., July 7, 1938 *(F 17468)*. A pale-liver-colored species occurring in dense imbricate masses on much-decayed hardwood logs in woods, and remarkable for its crowded gills, which number about 4 to a mm., the spaces between appearing as very fine lines. Found several times in the vicinity.

Gymnopus subluxurians sp. nov.

Pileo 5-7.5 cm. lato, atro-roseo-isabellino; sapore dulci; sporis ovoideis, hyalinis, 7-8 × 5-6 μ; stipite subconcolori, 5-7 cm. longo.

Pileus convex, often umbonate, gregarious, 5-7.5 cm. broad; surface smooth, dry, glabrous, uniformly dark rosy-isabelline or fulvous on the disk and isabelline toward the margin; context thin, white, sweet; lamellae adnexed, subconcolorous, narrow, crowded, entire; spores ovoid, tapering at one end, smooth, hyaline, 7-8 × 5-6 μ; stipe usually bent near the base, tapering upward, twisted, subglabrous, subconcolorous, whitish-mycelioid below, slender, 5-7 cm. long.

Type collected by W. A. Murrill in humus on a shaded lawn at Gainesville, Fla., August 18, 1937 *(F 15945)*. Also picked up several other times by the author on lawns in Gainesville, often growing in the grass without visible humus.

Marasmius Westii sp. nov.

Pileo convexo, 1.5-2 mm. lato, roseo-isabellino; lamellis adnatis, distantibus, sporis 6 × 3 μ; stipite glabro, nigro, 2 mm. longo.

Pileus convex, not fully expanding, gregarious, 1.5-2 mm. broad; surface dry, uneven, pruinose, uniformly rosy-isabelline, margin paler, sulcate at times over the lamellae; context membranous, rosy-isabelline, astringent, odorless; lamellae adnate, distant, about 10 in number, sometimes inserted, broad, entire, pallid; spores pip-shaped, smooth, hyaline, 1-2-guttulate, about 6 × 3 μ; stipe central or eccentric, straight or curved, smooth, glabrous, shining, blackish, very slender, about 2 mm. long, attached either to a rhizomorph or the substratum; rhizomorphs aerial, hair-like, very long and creeping, with short branches, smooth, glabrous, shining, black.

Type collected by Erdman West on dead sticks of laurel oak at Swan Lake, Fla., June 26, 1938 *(F 17211)*. A minute membranous species associated with long hair-like rhizomorphs which creep over the surface of the substratum.

Melanoleuca subterreiformis sp. nov.

Pileo convexo-expanso, 4-5 cm. lato, subviscido, umbrino, radiato-fibrilloso, farinaceo; lamellis confertis, albis; sporis ellipsoideis, 4-5 × 2-3 μ; stipite umbrino, 4 × 0.7-1 cm.

Pileus convex to expanded, solitary, 4-5 cm. broad; surface slightly viscid, umbrinous on the disk, with radiating fibrils of the same color, the broad marginal zone pallid, even, entire; context thin, white, unchanging, odor slight, taste decidedly farinaceous and agreeable; lamellae shallowly sinuate with slight decurrent tooth, crowded, ventricose, broad, inserted, very thin, entire, white; spores ellipsoid, smooth, hyaline, 4-5 × 2-3 μ; cystidia none; stipe subequal, slightly enlarged at apex and base, dry, solid, umbrinous with black parallel lines, 4 × 0.7-1 cm.

Type collected by W. A. Murrill in low woods of oak, hickory, etc. near Seven-mile Church, west of Gainesville, Fla., Dec. 16, 1941 *(F 19995)*. Found but once. Related to *M. subterrea* Murr., described from pine woods in Alabama.

Melanoleuca Watsonii sp. nov.

Pileo convexo-expanso, 6-13 cm. lato, glabro, griseo, farinaceo; lamellis albis vel subgriseis, sporis ellipsoideis, 4 × 2.5 μ; stipite glabro, albo, 4-7 × 1.5-3 cm.

Pileus convex to expanded, gregarious to subcespitose, reaching 13 cm. broad; surface smooth, glabrous, shining, pale-griseous to dark-griseous or murinous, margin even, becoming irregular or upturned with age; context thick, firm, white, unchanging, odor farinaceous, unpleasant in older caps, taste bitter-farinaceous; lamellae sinuate, adnate or slightly decurrent, medium broad and medium close, inserted, entire, white, sometimes pale-griseous with age; spores ellipsoid, smooth, hyaline, about 4 × 2.5 μ; stipe subequal, not bulbous, solid, smooth, glabrous, white, 4-7 × 1.5-3 cm.

Type collected by J. R. Watson and W. A. Murrill in low ground under live-oak in the west edge of Melrose, Alachua Co., Jan. 26, 1941 *(F 21512)*. Found in abundance at this one spot but not known from elsewhere. Related to *M. subargillacea* Murrill, described from Alabama.

Monadelphus Watsonii sp. nov.

Pileo convexo, 5-6 cm. lato, subfulvo, praefibrilloso, grato, anisato; lamellis praedecurrentibus, integris; sporis ovoideis, 7 × 5 μ; stipite striato, squamoso, pallido, 10 × 1-2 cm.

Pileus convex, not fully expanding, cespitose, 5-6 cm. broad; surface dry, uniformly pale-fulvous, densely fibrillose, margin incurved, even, entire; context white, unchanging, mild, with odor of anise; lamellae decidedly decurrent, inserted, moderately broad, subdistant, entire, brownish when dry; spores ovoid, smooth, hyaline, uniguttulate, about 7 × 5 μ; cystidia none; stipe tapering downward, tough, longitudinally striate, pallid, solid, decorated with large reflexed scales, about 10 × 1-2 cm.

Type collected by Prof. J. R. Watson on the ground in a high hammock, probably growing from buried wood, at Gainesville, Fla., Dec. 9, 1942 *(F 19628)*. Not seen elsewhere. Suggesting *Gymnopilus* when looked at from above. In texture it resembles *M. illudens*.

Omphalina australis sp. nov.

Pileo umbilicato, 1.7 cm. lato, glabro, avellaneo-isabellino, striato; lamellis distantibus, albis; sporis ellipsoideis, 7-8 × 4-5 μ; stipite glabro, albo, 3 × 0.2 cm.

Pileus convex, umbilicate, gregarious, reaching 1.7 cm. broad; surface dry, glabrous, hygrophanous, very pale avellaneous-isabelline with fuliginous center, reddish-brown when dry, margin entire, striate; context very thin, odorless; lamellae arcuate-decurrent, inserted, distant, medium broad, white, entire; spores ellipsoid, smooth, hyaline, uniguttulate, 7-8 × 4-5 μ; cystidia none; stipe slightly tapering downward, cartilaginous, smooth, glabrous, white, drying pale-reddish-brown, about 3 × 0.2 cm.

Type collected by W. A. Murrill in leaf-mold in low frondose woods at Gulf Hammock, Levy Co., Fla., Jan. 14, 1940 *(F 19334)*. Not collected elsewhere.

Omphalina brunnescens sp. nov.

Pileo umbilicato, 1 cm. lato, pruinoso, isabellino; lamellis angustatis, albis; sporis ellipsoideis, 6 × 4 μ; stipite glabro, 2 × 0.1-0.2 cm.

Pileus convex, umbilicate, not fully expanding, solitary, 1 cm. broad; surface hygrophanous, smooth, pruinose, isabelline with dark center, brownish when dry, margin incurved, even, entire; context very thin; lamellae short-decurrent, arcuate, inserted, narrow, subdistant, white, edges more or less eroded; spores ellipsoid, smooth, hyaline, about 6 × 4 μ; cystidia none; stipe subequal, smooth, glabrous, cartilaginous, pale-yellowish drying reddish-brown, 2 × 0.1-0.2 cm.

Type collected by W. A. Murrill in soil under an oak at Gainesville, Fla., July 6, 1938 *(F 17451)*. Not collected elsewhere. Both cap and stem turn brown in drying.

Omphalina fumosa sp. nov.

Pileo convexo, 1 cm. lato, fumoso; lamellis avellaneis, sporis hyalinis, 6-7 × 3-4 μ; stipite 2 × 0.1-0.2 cm.

Pileus convex, papillate, not umbilicate, gregarious, 1 cm. broad; surface smooth, finely pulverulent, uniformly fumosous, margin even, entire, incurved when young; context rather thin, grayish, odorless, mawkish; lamellae short-decurrent, arcuate, inserted, medium distant, avellaneous, the edges sinuate; spores pip-shaped, pointed at one end, smooth, hyaline, 6-7 × 3-4 μ; stipe slightly darker than the pileus, subequal, pruinose and pallid at the apex, 2 × 0.1-0.2 cm.

Type collected by W. A. Murrill on the ground under a pine in Gainesville, Fla., June 29, 1938 *(F 17283)*. A small gray species that is convex and does not expand.

Omphalina mellea sp. nov.

Pileo convexo, umbilicato, 1 cm. lato, glabro, melleo; sporis ellipsoideis, 6 × 4 μ; stipite melleo, 2 × 0.15 cm.

Pileus convex with small umbilicus, not expanding, gregarious, about 1 cm. broad; surface smooth, glabrous, pale melleous, isabelline at the center, margin even, entire; context thin, pallid, odorless; lamellae short-decurrent, pallid, medium distant, entire; spores ellipsoid, smooth, hyaline, uniguttulate, about 6 × 4 μ; stipe equal, concolorous, smooth, glabrous, about 2 × 0.15 cm.

Type collected by W. A. Murrill in soil under a pine at Gainesville, Fla., June 30, 1938 *(F 17301)*. A hemispheric, pale-yellowish species only slightly umbilicate.

Omphalina subchrysophylla sp. nov.

Pileo convexo, umbilicato, 5-8 mm. lato, umbrino; lamellis angustatis, citrinis, sporis globosis, 3 μ; stipite pallido, subglabro, 1-2 × 0.1 cm.

Pileus convex to expanded, umbilicate, gregarious, 5-8 mm. broad; surface rugose, sulcate, dry, glabrous, umbrinous, margin entire; context membranous, pallid, slightly astringent; lamellae decurrent, narrow, distant, inserted, citrinous, the edges brownish and slightly eroded; spores globose, smooth, hyaline, uninucleate, about 3 μ; stipe twisted, smooth, subglabrous, pallid, stuffed, equal above the enlarged, white-tomentose base, 1-2 × 0.1 cm.

Type collected by West and Murrill on a dead oak branch in Planera Hammock, eleven miles northwest of Gainesville, Fla., July 20, 1938 *(F 18761)*. Resembling *O. chrysophylla* (Fries) Murrill, but much smaller. It is nearer to *O. subclavata* (Peck) Murrill. Found several times in Alachua and Marion Counties.

Omphalopsis pernivea sp. nov.

Pileo convexo, 9 mm. lato, albo, striato; lamellis distantibus; sporis 8-10 × 2.5 μ; cystidiis 25 × 20 μ; stipite albo, 1.5 × 0.1 cm.

Pileus hemispheric with a small umbo, not fully expanding, solitary, 9 mm. broad; surface dry, smooth, glabrous, striate, white, pellucid except at the center, margin straight, entire; context membranous, white, odorless; lamellae decurrent, arcuate, distant, medium broad, inserted, white, entire; spores narrowly oblong, smooth, hyaline, granular, tapering and obliquely apiculate at the base, about 8-10 × 2.5 μ; cystidia numerous, broadly ellipsoid with an abrupt conic apex, smooth, hyaline, about 25 × 20 μ; stipe subequal, smooth, glabrous, pellucid, 1.5 cm. long, scarcely 1 mm. thick.

Type collected by W. A. Murrill in sand under palmettoes at Gainesville, Fla., Sept. 30, 1939 *(F 20001)*. A very dainty little mushroom, pure-white throughout, with inflated cystidia and long, narrow spores.

Prunulus alachuanus sp. nov.

Pileo conico-expanso-revoluto, caespitoso, 2.5-3.5 cm. lato, glabro, fumoso, grato; lamellis sinuatis, latis, murinis; sporis ovoideis, levibus, 8-9 × 5-7 μ; stipite glabro, concolori, praeradicato, 6-10 × 0.5-1 cm.

Pileus conic to expanded, umbonate at times, cespitose, 2.5-3.5 cm. broad; surface smooth, glabrous, blackish to dark-fumosus when young and fresh, paler with age, margin even, entire, becoming revolute; context thin, white, odorless, mild; lamellae inserted, sinuate, broad, ventricose, medium crowded, entire, grayish-murinous; spores broadly ovoid, smooth, hyaline, uniguttulate, 8-9 × 5-7 μ; stipe tapering upward, smooth, glabrous, hollow, concolorous, long-radicate, about 6-10 × 0.5-1 cm.

Type collected by W. A. Murrill in low frondose woods, growing from decayed buried wood, in Sugarfoot Hammock, near Gainesville, Fla., Jan. 24, 1943 *(F 21466)*. Found but once.

Prunulus subrubridiscus sp. nov.

Pileo convexo-plano, 7 mm. lato, pallido, disco rubro-fulvo; lamellis adnatis vel adnexis, latis, pallidis; sporis ellipsoideis, 6 × 4 μ; stipite glabro, pallide-flavo, 2.5-3 × 0.1 cm.

Pileus convex to plane, gregarious, about 7 mm. broad; surface smooth, subglabrous, pallid, reddish-fulvous on the disk, margin even, entire; context thin, white; lamellae adnate or adnexed, tapering behind, inserted, broad, distant, pallid, entire; spores ellipsoid, smooth, hyaline, about

$6 \times 4\,\mu$; stipe equal, smooth, glabrous, pale-yellow, drying reddish-brown, white at the base, $2.5\text{-}3 \times 0.1$ cm.

Type collected by W. A. Murrill on a wet shaded bank at Magnesia Springs, Alachua Co., Fla., July 15, 1938 *(F 19322)*. Not found elsewhere.

Venenarius cylindrisporiformis sp. nov.

Pileo convexo-expanso, 4-6 cm. lato, albo, glabro, demum striato; lamellis angustibus, albis, denticulatis; sporis elongato-ovoideis, $10 \times 6\,\mu$; stipite albo, glabro, $7\text{-}15 \times 0.7\text{-}1$ cm.; volva alba, ampla, 4.5×2 cm.; annulo albo, amplo.

Pileus convex, at length expanding, 4-6 cm. broad; surface white, glabrous, margin entire, even, becoming striate with age; context thin, white, odorless; lamellae adnexed with long decurrent ridge, medium distant, narrow, denticulate, white, brownish after drying; spores elongate-ovoid, smooth, hyaline, about $10 \times 6\,\mu$; cystidia none; stipe white, glabrous, tapering upward, $7\text{-}15 \times 0.7\text{-}1$ cm.; volva large, with free limb, white, about 4.5 cm. high and 2 cm. broad; annulus ample, white, fixed.

Type collected by W. A. Murrill in a hammock near Green Cove Springs, Clay Co., Fla., July 27, 1939 *(F 16301)*. Also collected by Arnold and West in deep sand south of Gold Head Branch State Park, May 12, 1939 *(F 18718)*, and by the author in sandy mixed woods in the same park, May 27, 1939 *(F 17677)*. Similar in form to *Amanitopsis volvata* but having a ring, and greatly resembling *Amanita cylindrispora* Beardslee but lacking the cylindric spores of that species.

Venenarius parvus sp. nov.

Pileo convexo-depresso, 3 cm. lato, albo; sporis $10\text{-}13 \times 3\text{-}4\,\mu$; stipite albo, bulboso, 5×0.5 cm.; annulo magno, albo, persistente.

Pileus convex to somewhat depressed, solitary, 3 cm. broad; surface slightly viscid, smooth, glabrous or nearly so, white, margin even, entire, projecting 2-3 mm.; context thin, white, unchanging, odorless; lamellae adnate without decurrent ridges, ventricose, inserted, a few forked, medium distant, rather broad, pallid, the edges distinctly fringed; spores elongate, smooth, hyaline, $10\text{-}13 \times 3\text{-}4\,\mu$; stipe equal and 5×0.5 cm. above the bulb, white, pruinose at the apex, floccose below, somewhat discolored where handled; bulb subglobose, large, white, not radicate; annulus 5 mm. from the apex, large, white, membranous, fixed, not striate, hanging like a wet skirt.

Type collected by W. A. Murrill under an oak in Gainesville, Fla., June 21, 1938 *(F 17404)*. A small, white species with cylindric spores, reminding one of *V. vernus*. Also collected by West and Murrill under hardwood trees in Planera Hammock, eleven miles northwest of Gainesville, August 2, 1938 *(F 17405)*.

Venenarius pseudovernus sp. nov.

Pileo convexo-expanso, 4-6 cm. lato, glabro, albo vel disco cremeo; lamellis adnexis, confertis, angustatis, albis; sporis ellipsoideis, $8\text{-}10 \times 6\text{-}7\,\mu$; stipite albo, bulboso, eradicato, $8\text{-}12 \times 1\text{-}1.5$ cm.; bulbo

4 × 3-4 cm.; volva lobata vel lacerata; annulo amplo, persistenti, albo.

Hymenophore pure-white throughout, or with cream disk; pileus convex to expanded, 4-6 cm. broad; surface smooth, glabrous, rarely with volval patches, margin even, entire; context odorless; lamellae adnexed, inserted, close, narrow, entire, brown when dry; spores broadly ellipsoid, about 8-10 × 6-7 μ; stipe tapering upward, floccose, at times very rough, 8-12 × 1-1.5 cm.; bulb large, ovoid, not radicate, about 4 × 3-4 cm.; volva limb free, lobed or lacerate; annulus very large, fixed 1 cm. from apex, persistent.

Type collected by W. A. Murrill under an oak at Gainesville, Fla., May 29, 1938 *(F 16413)*. Also collected by the author under oak in the vicinity on June 15, 1938 *(F 16466)*. Although the pileus in this latter collection had a cream disk I believe it is not distinct. On June 30, 1938, Mr. West collected typical white specimens under oak in Sugarfoot, near Gainesville *(F 17410)*. On Oct. 3, 1943, I collected specimens in the same locality with a cream disk *(F 21531)*. The spores of *V. vernus* are globose. Unless one examines the spores, it is easy to confuse the two species.

Venenarius Westii sp. nov.

Pileo convexo, 7-9 cm. lato, rubro-brunneo, anisato; sporis subellipsoideis, 9-11 × 6-7 μ; stipite concolori, valde bulboso, 7-9 × 1.5 cm., annulo magno.

Pileus convex, not fully expanding, gregarious, 7-9 cm. broad; surface dry, uniformly pale reddish-brown, decorated with large, floccose, concolorous scales, which are more abundant and more erect on the disk; margin undulate, roughly squamulose, thick, not striate; context thick, white, reddish-tinted where cut, sweet and nutty, with a slight odor of anise; lamellae adnate, breaking away from the stipe, medium distant, inserted, broad but not ventricose, pale grayish-white, reddish-brown when dry, the edges very thick and finely fringed but not eroded; spores oblong-subellipsoid with one end smaller, smooth, hyaline, granular, about 9-11 × 6-7 μ; stipe equal above the bulb, pruinose and striate at the paler apex, shaggy and concolorous below, 7-9 × 1.5 cm.; bulb ovoid, concolorous, 3 cm. thick, slightly radicate, volva limb fragile, carried aloft; annulus apical, very large, membranous, skirt-like, striate, fixed, persistent, pale reddish-brown.

Type collected by Erdman West under *Quercus geminata* Small at Newnan's Lake, near Gainesville, Fla., July 7, 1938 *(F 17466)*. A very striking pale-chocolate-colored species with spores resembling those of *Amanita Atkinsoniano* Coker. No trace of chloride-of-lime odor was present but a slight fragrance as of anise. The enormous bulb banishes at once all thought of *V. rubens* and its relatives.

Eccilia floridana sp. nov.

Pileo convexo, umbilicato, 1-2 cm. lato, avellaneo, farinaceo; lamellis distantibus, sporis angulatis, 8-9 × 5-6 μ; stipite albido, 1 × 0.1 cm.

Pileus convex, deeply umbilicate, gregarious, 1-2 cm. broad; surface hygrophanous, subglabrous, smooth, uniformly avellaneous, margin even, entire, incurved when young; context thin, pallid, odor and taste strongly farinaceous; lamellae decurrent, distant, inserted, triangular, entire, pallid to dull-pink; spores angular, apiculate, uniguttulate, pink, about 8-9 × 5-6 μ; cystidia none; stipe equal, smooth, slightly fibrillose, pallid, about 1 × 0.1 cm.

Type collected by W. A. Murrill on bare, moist soil under palms in Gainesville, Fla., July 17, 1938 *(F 17887)*. A small, convex, avellaneous species with decidedly farinaceous odor and taste. It is related to *E. parvula* Murrill.

Entoloma albidiforme sp. nov.

Pileo convexo-depresso, umbonato, 4.5 cm. lato, subavellaneo; sporis angulatis, 10 × 7 μ; stipite albo, 5-6 × 0.4-0.8 cm.

Pileus convex to slightly depressed with a small but distinct umbo, gregarious, 4.5 cm. broad; surface avellaneous with a slight rosy tint, hygrophanous, shining and nearly white in drying, glabrous, marked with a few scattered radiating whitish ridges; margin even, undulate to slightly lobed; context very thin, pallid, odorless, mild; lamellae sinuate, very broad behind, distant, entire, pallid to dull-pink, the shorter ones much narrower; spores very angular, uniguttulate, pink, about 10 × 7 μ; stipe strongly tapering upward, pruinose to subglabrous, grooved, pearly-white, 5-6 × 0.4-0.8 cm.

Type collected by West and Murrill on mossy ground under hardwood trees in Planera Hammock, eleven miles northwest of Gainesville, Fla., August 2, 1938 *(F 17391)*. A neat, mammillate species that is opaque when fresh but becomes shining and almost white soon after being placed in the drying oven.

Entoloma floridanum sp. nov.

Pileo convexo-plano, 5-7 cm. lato, avellaneo; odore et sapore valde farinaceis; lamellis sinuatis, latis, albis; sporis angulatis, roseis, 8.5-11 μ; stipite albo, 4-6 × 1-2 cm.

Pileus convex to plane, gregarious, 5-7 cm. broad; surface smooth, glabrous, shining when dry, uniformly avellaneous, margin even, entire; context firm, white, unchanging, odor and taste strongly farinaceous; lamellae sinuate, broad, not crowded, 3-4 times inserted, entire, white to pink; spores apiculate, angular, pink, 8.5-11 μ; stipe subequal, smooth, glabrous, milk-white, stuffed, 4-6 × 1-2 cm.

Type collected by W. A. Murrill in soil beneath a laurel oak at Gainesville, Fla., Nov. 22, 1932 *(F 10012)*. Found abundant in one spot. Near *E. griseum*, but stipe pure white; also near *E. Grayanum*, but stipe much too short and thick. A single specimen was found on Sept. 30, 1932, with the margin deeply split in several places *(F 10013)*. Rather common in Alachua County.

Entoloma muriniforme sp. nov.

Pileo convexo-expanso, umbonato, 2.5 cm. lato, rimoso, avellaneo, nigro-squamuloso; lamellis sinuatis, latis, pallidis; sporis angulatis, 7 × 5 μ; stipite glabro, albo, 2.5 × 0.3 cm.

Pileus convex to expanded-umbonate, solitary, 2.5 cm. broad; surface dry, rimose, avellaneous with blackish pointed scales, darker on the umbo, margin concolorous; context thin, dirty-pallid; lamellae sinuate, inserted, broad, medium distant, pallid to pinkish, finely denticulate; spores ellipsoid in outline, decidedly angular, uniguttulate, about 7 × 5 μ; cystidia none; stipe equal, smooth, glabrous, white, 2.5 × 0.3 cm.

Type collected by West & Murrill on the ground in Kelley's Hammock, 10 mi. northwest of Gainesville, Fla., July 19, 1938 *(F 18219).* Not found elsewhere. Suggesting *E. murinum* Pk. but quite distinct.

Entoloma subtenuipes sp. nov.

Pileo convexo-subexpanso, subumbonato, 2-3 cm. lato, subsquamuloso, fumoso-avellaneo, farinaceo; lamellis sinuatis, latis; sporis angulatis, 8 × 6 μ; stipite glabro, 4-6 × 0.2-0.3 cm.

Pileus convex to subexpanded with small umbo, gregarious, 2-3 cm. broad; surface densely subsquamulose, fumose-avellaneous, fumose on the umbo, margin entire, concolorous, fertile; context thin, odorless, taste very farinaceous; lamellae sinuate, broad, moderately close, inserted, edges undulate and pallid; spores pink, decidedly angular, 1-guttulate, about 8 × 6 μ; cystidia none; stipe slightly tapering upward, fleshy, smooth, glabrous, concolorous or paler, 4-6 × 0.2-0.3 cm.

Type collected by Erdman West on a rotten hardwood stump in Planera Hammock, eleven miles northwest of Gainesville, Fla., Jan. 5, 1939 *(F 15519).* Suggesting *Entoloma tenuipes* Murr., described from Lake Placid, N. Y., and also certain species of *Nolanea.*

Leptoniella alachuana sp. nov.

Pileo subdepresso, 1.5 cm. lato, violaceo-brunneo; lamellis adnatis, albis, latis; sporis angulatis, 9 × 6 μ; stipite violaceo vel albido, compresso, 3.5-4 × 0.3-0.5 cm.

Pileus slightly depressed, 1.5 cm. broad; surface dry, smooth, violet-brown, shining when fresh, densely squamulose under a lens, margin incurved, even, undulate, concolorous; context very thin, white, odorless; lamellae adnate or slightly sinuate, broad, rather distant, inserted, white to pale-rose, edges slightly uneven; spores pink, decidedly angular, 1-guttulate, about 9 × 6 μ; stipe slightly tapering upward, hollow, flattened, furfuraceous at the apex, violet above, paler violet or whitish below with the appearance of asbestos, 3.5-4 × 0.3-0.5 cm.

Type collected by R. C. Hindery and E. West in humus under oaks in Sugarfoot Hammock, near Gainesville, Fla., Sept. 11, 1942 *(F 19579).*

Leptoniella floridana sp. nov.

Pileo convexo, umbilicato, umbrino, 2-2.5 cm. lato; lamellis subdistantibus, sporis angulatis, 7-9 × 5-6 μ; stipite glabro, pallido, 3-4 × 0.1-0.2 cm.

Pileus convex, umbilicate, gregarious or cespitose, 2-2.5 cm. broad; surface dry, umbrinous, fuliginous in the center, finely hispid, often radiate-rimose, margin entire; context thin, concolorous, mild, odorless; lamellae adnate or sinuate with decurrent tooth, subdistant, inserted, rather broad, pallid to pale pink with brown edges; spores broadly ellipsoid in outline, decidedly angular, apiculate, uninucleate, pale pink, 7-9 × 5-6 μ; cystidia none; stipe equal, smooth, glabrous, pallid, whitish-tomentose at the base, about 3-4 × 0.1-0.2 cm.

Type collected by W. A. Murrill on a shaded lawn in Gainesville, Fla., July 17, 1938 *(F 17892)*. Suggesting *L. abnormis* (Peck) Murrill, but narrowly umbilicate and having a longer stipe.

Nolanea floridana sp. nov.

Pileo conico, umbrino, striato, 1 cm. lato; sporis angulatis, 6-8 μ; stipite glabro, pallido, 2 × 0.1 cm.

Pileus conic, umbonate, not expanding, gregarious, about 1 cm. broad; surface dry, furfuraceous, umbrinous, subfuliginous on the umbo, margin straight, entire, striate; context thin, pallid, odorless, mild; lamellae free or slightly adnexed, broad, ventricose, inserted, subdistant, pallid to pale pink, the edges entire, concolorous; spores globose to broadly ellipsoid in outline, decidedly angular, uninucleate, apiculate, pink, 6-8 μ in diameter; cystidia none; stipe equal, smooth, glabrous, pallid, about 2 × 0.1 cm.

Type collected by W. A. Murrill on a shaded lawn in Gainesville, Fla., July 17, 1938 *(F 17879)*. A small, conic, umbrinous species found in the grass under hardwood trees.

Nolanea strobilomyces sp. nov.

Pileo conico-convexo, 5-7 mm. lato, fuliginoso, floccoso; lamellis adnexis, latis, integris; sporis 4-5-angulatis, 6 μ; stipite concoloro, floccoso, 1.5 × 0.1 cm.

Pileus conic to hemispheric, gregarious, 5-7 mm. broad; surface fuliginous, shaggy, margin entire, straight; context very thin, brown; lamellae adnexed, inserted, broad, ventricose, medium distant, entire, gray to reddish-brown; spores (appear) 4-5-angled, opaque, dark-roseous, about 6 μ; cystidia none; stipe equal, concolorous, shaggy, about 1.5 × 0.1 cm.

Type collected by W. A. Murrill on a dead log in Kelley's Hammock, 10 mi. northwest of Gainesville, Fla., Aug. 10, 1938 *(F 16520)*. A very striking little species strongly suggesting *Strobilomyces*. The spores suggest dark, crudely-cut amethysts. It is novelties like these that repay the mycologist for overtime.

Pluteus alachuanus sp. nov.

Pileo convexo-plano, 3-3.5 cm. lato, umbrino, reticulato; lamellis confertis, sporis globosis, 5 μ; stipite albo, striato, 5 × 0.3-0.4 cm.

Pileus convex to plane, not umbonate, gregarious, 3-3.5 cm. broad; surface hygrophanous, glabrous, pale-umbrinous, fuliginous on the disk, ornamented with serpentine reticulate fuliginous lines; margin straight, even, entire, fertile; context very thin, white, mild, odorless; lamellae free, ventricose, broad, rather close, inserted, entire, pallid to pink; spores globose, smooth, pink, 1-guttulate, about 5 μ; stipe tapering upward, whitish, shining, striate, glabrous above, tomentose below, 5 × 0.3-0.4 cm.

Type collected by W. A. Murrill on a rotten sweet-gum log in a low hammock at Magnesia Springs, Fla., Feb. 11, 1939 *(F 18713)*. The reticulate cap suggests *P. admirabilis* Peck, but the spores are uniformly globose. It is also near *P. phlebophorus* (Ditm.) Fr. Collected later on a decayed palmetto at Juniper Springs.

Pluteus australis sp. nov.

Pileo convexo-subexpanso, 2 cm. lato, viscido, glabro, cervino; lamellis liberis, confertis, albis; sporis ellipsoideis, 5 × 3 μ; cystidiis trifidis, 45 × 13 μ; stipite albo, glabro, 7 × 0.3 cm.

Pileus convex to subexpanded, solitary, 2 cm. broad; surface slimy-viscid, smooth, glabrous, dark fawn-colored, darker on the disk, margin even, entire; context thin, white; lamellae free, inserted, narrow, crowded, white to pink; spores ellipsoid, smooth, uniguttulate, about 5 × 3 μ; cystidia abundant, hyaline, conic with trifid apex, projecting about 45 × 13 μ; stipe equal, dry, smooth, glabrous, white, 7 × 0.3 cm.

Type collected by W. A. Murrill in humus in a high hammock at Gainesville, Fla., Oct. 24, 1942 *(F 19140)*. Resembling *P. cervinus* but smaller and slenderer. Found but once.

Pluteus subgriseibrunneus sp. nov.

Pileo convexo, umbonato, 5 cm. lato, griseo, tomentuloso, striatulato; sporis subglobosis, 6-7 × 5-6 μ; stipite albo, 6-7 cm. longo.

Pileus convex, umbonate, solitary, 5 cm. broad; surface dry, finely tomentose, uniformly gray, with blackish erect fibrils, margin faintly striate, entire; context thin, white; lamellae free, broad, crowded, entire, pallid to pink; spores subglobose, smooth, uniguttulate, pink, 6-7 × 5-6 μ; cystidia bottle-shaped, hyaline; stipe tapering upward, pulverulent to subglabrous, white, about 6-7 cm. long.

Type collected by W. A. Murrill on a dead log in woods a few miles west of Gainesville, Fla., Aug. 16, 1937 *(F 16067)*. A beautiful species suggesting *P. griseibrunneus*, but the spores are decidedly different.

Galerula melleiceps sp. nov.

Pileo convexo-plano, umbonato, 5-10 mm. lato, pulverulento, striato, melleo; lamellis adnatis, latis, pallidis; sporis ovoideis, 6-7 × 4-5 μ; stipite glabro, melleo, 1.5 × 0.05 cm.

Pileus convex to plane, umbonate, gregarious, 5-10 mm. broad; surface dry, pulverulent, striate, honey-yellow, margin straight, entire or slightly lobed; context very thin, pallid; lamellae adnate, inserted, broad, subdistant, dirty-pallid, entire; spores ovoid, smooth, uniguttulate, pale-isabelline, 6-7 × 4-5 μ; cystidia none; stipe equal, smooth, glabrous, pale-melleous, about 1.5 × 0.05 cm.

Type collected on a dead frondose log at Buzzards' Roost, 8 mi. west of Gainesville, Fla., Sept. 29, 1938 *(F 15910)*. Not seen elsewhere.

Galerula parvuliformis sp. nov.

Pileo conico-plano, umbonato, 1.3 cm. lato, rosei-isabellino, striato;

lamellis adnexis, ventricosis; sporis ovoideis, levibus, 8-11 × 5-7 μ; stipite albo, floccoso, 2 × 0.1 cm.

Pileus conic to plane with prominent conic umbo, 1.3 cm. broad; surface dry, floccose-scaly, finely striate to the umbo, pale rosy-isabelline, dark-isabelline at the center, margin entire, straight, appressed when young; context very thin, pallid; lamellae adnexed, rounded behind, ventricose, inserted, medium distant, entire, soon pale-isabelline; spores ovoid, smooth, uniguttulate, isabelline, very variable in size, 8-11 × 5-7 μ; stipe white, finely floccose, equal, 2 × 0.1 cm.

Type collected by W. A. Murrill in soil under an oak at Gainesville, Fla., June 4, 1938 *(F 19882)*. Not found elsewhere.

Gymnopilus fulviconicus sp. nov.

Pileo conico, 3 cm. lato, glabro, subfulvo, disco fulvo; lamellis adnatis, latis, integris; sporis ovoideis, levibus, 7 × 4 μ; stipite glabro, subconcoloro, 5 × 0.7 cm.

Pileus conic, not fully expanding, solitary, about 3 cm. broad; surface smooth, glabrous, fulvous on the disk, paler toward the margin, which is even, entire, incurved when dry; context thin, pallid, odorless, mild; lamellae adnate with decurrent tooth, inserted, broad, medium distant, entire, ferruginous at maturity; spores ovoid, smooth, pale-yellowish, about 7 × 4 μ; cystidia none; stipe subequal, smooth, glabrous, pale-yellowish above, fulvous below, about 5 × 0.7 cm.

Type collected by W. A. Murrill on the ground in beech woods near Santa Fé, Alachua Co., Fla., Dec. 13, 1939 *(F 18110)*. Not known from elsewhere. On drying the center becomes a fulvous cone. Scattered over the sides of the gills are globose fulvous bodies 15 μ or more in diameter.

Hebeloma australe sp. nov.

Pileo convexo-subexpanso, 4-5 cm. lato, glabro, subviscido, rosei-isabellino, amaro; lamellis adnexis, latis, confertis, denticulatis; sporis ovoideis, levis, pallidis, 10-12 × 5-6 μ; stipe pallido, floccoso, bulboso, 4-5 × 0.6-0.8 cm.

Pileus convex to subexpanded, often slightly elevated at the center, gregarious, 4-5 cm. broad; surface smooth, glabrous, slightly viscid, pale rosy-isabelline, margin even, entire, inflexed on drying; context thin, white, odorless, bitter; lamellae adnexed, inserted, crowded, broad, ventricose, dull-brown when mature and dry with white-fringed edges; spores ovoid, smooth, uniguttulate, inequilateral, 10-12 × 5-6 μ; cystidia none; stipe tapering downward to the small bulb, floccose, dirty-white, 4-5 × 0.6-0.8 cm.

Type collected by W. A. Murrill under live-oak west of Newnan's Lake, near Gainesville, Fla., Dec. 28, 1942 *(F 21535)*. Also collected by Dr. G. F. Weber at the same place. The bitter taste is not always present.

Hebeloma longisporum sp. nov.

Pileo conico-convexo, 3 cm. lato, viscido, glabro, subisabellino, subgrato; lamellis sinuatis, latis; sporis ovoideis, levibus, 14 × 7 μ; stipite glabro, viscido, pallido, 5-6 × 0.5-0.7 cm.

Pileus conic to broadly convex, 3 cm. broad; surface viscid, smooth, glabrous, avellaneous-isabelline, dark-isabelline on the disk, margin even, entire; context very thin except at the center, pallid, odorless, mild to slightly mawkish; lamellae sinuate, inserted, broad, ventricose, medium distant, entire, pallid when young; spores elongate, pipshaped, smooth, uniguttulate, about 14 × 7 μ; stipe equal, smooth, glabrous, viscid, pallid, shining, stuffed, 5-6 × 0.5-0.7 cm.

Type collected by W. A. Murrill in mixed woods very near Gainesville, Fla., Oct. 29, 1938 *(F 19201)*. Not found elsewhere.

Hebeloma subfastible sp. nov.

Pileo convexo-plano, 2.5-4 cm. lato, roseo-isabellino; lamellis latis, pallidis; sporis subfusiformibus, glabris, ochraceo-ferrugineis, 11-13 × 5-6 μ; stipite albo, 3 × 0.5-1 cm.

Pileus convex to plane, not at all umbonate, gregarious, 2.5-4 cm. broad; surface smooth, moist, glabrous, uniformly rosy-isabelline, margin even, entire; context thin, white; lamellae sinuate, broad, subcrowded, pallid to subferruginous, edges white, denticulate; spores smooth, subfusiform, uniguttulate, ochraceous-ferruginous, 11-13 × 5-6 μ; stipe equal, short, smooth, glabrous, white, about 3 × 0.5-1 cm.

Type collected by W. A. Murrill on a lawn under oaks at Gainesville, Fla., Jan. 8, 1938 *(F 16041)*. Strongly suggesting *H. crustuliniforme*, only smaller and uniformly rosy-isabelline. The spores are entirely different, being subfusiform instead of gibbous. No characteristic odor was noticed. Common about Gainesville on lawns and in woods.

Inocybe hebelomoides sp. nov.

Pileo convexo-expanso, umbonato, 3.5 cm. lato, viscido, stramineo; sporis ovoideis, 8 × 5 μ, cystidiis 40 × 15 μ; stipite albo, 5 × 0.5-0.6 cm.

Pileus convex to expanded, umbonate, gregarious, 3.5 cm. broad; surface viscid, smooth, shining, glabrous, stramineous, margin even, entire; context white, unchanging, without characteristic odor or taste; lamellae adnexed with decurrent tooth, ventricose, medium broad and medium distant, inserted, pallid to discolored, edges fimbriate; spores ovoid, smooth, ferruginous, 1-guttulate, about 8 × 5 μ; cystidia bottle-shaped, hyaline, blunt and crested at the tip, projecting about 40 × 15 μ; stipe equal, smooth, shining, glabrous, white, furfuraceous at the apex, 5 × 0.5-0.6 cm.

Type collected by W. A. Murrill under hardwoods in a high hammock at Gainesville, Fla., Oct. 17, 1938 *(F 18365)*. Having the usual appearance of *Hebeloma* with cystidia like those of *Inocybe* and spores resembling those of *Cortinarius*. They are umbrinous in mass and ferruginous under the microscope.

Inocybe minutispora sp. nov.

Pileo conico-subexpanso, 2-2.5 cm. lato, subviscido, avellaneo-isabellino, innato-fibrilloso; lamellis adnexis, confertis; sporis angulatis, tuberculatis, 5-6 × 3-4 μ; cystidiis ventricosis, tuberculatis, projectentibus 30 × 15 μ; stipite glabro, albo, bulboso, 3-5 × 0.2-0.3 cm.

Pileus conic to convex, at length subexpanded, gregarious, 2-2.5 cm. broad; surface somewhat viscid, silky-shining, avellaneous-isabelline, innate-fibrillose, margin entire, finely striate when dry; context thin, white; lamellae adnexed with decurrent tooth, inserted, narrow, crowded, fulvous at maturity; spores small, angular-tuberculate, irregular, pale, opaque, about 5-6 × 3-4 μ; cystidia abundant, ventricose with tubercular tip, hyaline, projecting about 30 × 15 μ; stipe smooth, glabrous, milk-white, subequal above the nonmarginate bulb, about 3-5 × 0.2-0.3 cm.

Type collected by W. A. Murrill in sandy, shaded soil in Kelley's Hammock, ten miles northwest of Gainesville, Fla., July 19, 1938 *(F 18552).* Not found elsewhere.

Inocybe multispora sp. nov.

Pileo convexo, umbonato, gregaro, 1-2 cm. lato, squamuloso, isabellino ad fulvo, grato; lamellis adnatis, latis, fimbriatis; sporis ellipsoideis, levibus, pallidis, 10-13 × 4-6 μ; stipite pallido, fibrilloso, 1.5-3 × 0.2-0.4 cm.

Pileus convex with prominent conic umbo, gregarious, 1-2 cm. broad; surface dry, coarsely squamulose, pale-isabelline to fulvous, margin even, entire, inflexed on drying; context thin, sweet; lamellae broadly adnate, inserted, broad, medium distant, white-fimbriate; spores oblong-ellipsoid, smooth, pale, 1-2-guttulate, very abundant, 10-13 × 4-6 μ; cystidia none; stipe subequal above the small immarginate bulb, fibrillose, pallid, 1.5-3 × 0.2-0.4 cm.

Type collected by W. A. Murrill under a palm in Gainesville, Fla., June 8, 1938 *(F 17380).* Also collected by the author in the vicinity during July and October of the same year, both in the open and in mixed woods.

Inocybe sublongipes sp. nov.

Pileo convexo-plano, 1.5-2.2 cm. lato, subisabellino, innato-fibrilloso, grato; lamellis adnatis, latis, albis, fimbriatis; sporis oblongo-ovoideis, levibus, 11-13 × 5-6 μ; stipite pallido, fibrilloso, 5-6 × 0.2-0.4 cm.

Pileus convex, plane in age, slightly umbonate, scattered to gregarious, 1.5-2.2 cm. broad; surface dry, uniformly pale-isabelline, shining, finely innately radiately floccose or tomentose, margin incurved when young, even, entire; context very thin, white to discolored, odorless, mild; lamellae adnate, broad, ventricose, crowded, white to isabelline, white-fimbriate; spores oblong-ovoid, smooth, 1-guttulate, isabelline, 11-13 × 5-6 μ; cystidia none; stipe subequal, grayish, fibrillose, 5-6 × 0.2-0.4 cm.; veil fibrillose, delicate, white, evanescent.

Type collected by W. A. Murrill under elbow bushes at the edge of a flatwoods pond east of Gainesville, Fla., Aug. 27, 1943 *(F 22467).* In the group with *I. subdecurrens* but paler and having a longer stem, suggesting that of *I. longipes;* which, however, has cystidia. The hymenophores were distributed for several yards along the edge of the pond.

Inocybe taedophila sp. nov.

Pileo convexo-depresso, gregario, 3-4.5 cm. lato, tomentoso, fulvo ad umbrino, grato; lamellis adnatis, latis, ochraceis; sporis oblongis, levibus; 10-12 × 3-4 μ; stipite pallido, 2.5-3 × 0.5-1 cm.

Pileus convex to depressed, gregarious, 3-4.5 cm. broad; surface dry, tomentose, fulvous or umbrinous, margin entire, even or slightly striate; context thin, pallid, odorless, mild; lamellae inserted, squarely adnate or slightly sinuate, broad, rather close, entire, ochraceous-isabelline to ochraceous-fulvous; spores oblong, smooth, very pale yellowish under microscope, ochraceous-fulvous in mass, 10-12 × 3-4 μ; cystidia none; stipe subequal, pallid, often rough and striate, slightly enlarged at base, 2.5-3 × 0.5-1 cm.

Type collected by W. A. Murrill under loblolly pines northwest of Gainesville, Fla., Jan. 13, 1940 *(F 22484)*. Also collected in the same locality Jan. 10, 1940 *(F 22505)*., and Jan. 10, 1941 *(F 22516)*. On Jan. 14, 1940, it was collected in dry woods of loblolly pine and turkey oak near Archer, in Alachua Co., Fla. *(F 22507)*. These last specimens were bay to chestnut with age. The species is evidently adapted to the dry soil beneath *Pinus Taeda* and will doubtless be found under longleaf pine. It is in the general group with *I. subdecurrens* but its spores are unusually slender.

Inocybe umbrinescens sp. nov.

Pileo convexo-expanso, umbonato, 1-2 cm. lato, subfulvo, fibrilloso; lamellis adnexis, pallidis; sporis nodulosis, 10-12 × 9 μ; cystidiis ventricosis, hyalinis; stipite pallido ad nigro, pruinoso, 2-2.5 × 0.1-0.2 cm.

Pileus convex to expanded, umbonate, gregarious, 1-2 cm. broad; surface dry, densely fibrillose, becoming rimose, subfulvous, fulvous at the center, umbrinous on drying, margin entire, incurved when dry; context thin, pallid to brown; lamellae adnexed, inserted, rather broad, medium close, entire, pallid to brown; spores angular-nodulose, subglobose to broadly ellipsoid in outline, pale, with nodules short and obtuse, about 10-12 × 9 μ; cystidia abundant, hyaline, shaped like milk bottles but with tapering base, projecting about 30 μ; stipe pallid to black, smooth, pruinose, equal, without conspicuous bulb, about 2-2.5 × 0.1-0.2 cm.

Type collected by W. A. Murrill on a shaded lawn in Gainesville, Fla., Sept. 18, 1938 *(F 18707)*. Collected but once. The change in color on drying is very characteristic.

Inocybe Weberi sp. nov.

Pileo convexo-subexpanso, 3 cm. lato, innato-fibrilloso, melleo; lamellis sinuatis, adnexis, melleis, fimbriatis; sporis ovoideis, levibus, 8-9 × 5 μ; stipite pallido, bulboso, 5-6 × 0.5 cm.

Pileus convex to subexpanded, solitary, 3 cm. broad; surface dry, innate-fibrillose, melleous, the disk darker, margin even, entire; context thin, pale-yellowish, odorless, mild to mawkish; lamellae sinuate-adnexed, medium broad, medium distant, inserted, melleous, white-fimbriate; spores ovoid, smooth, about 8-9 × 5 μ; stipe subequal above the nonmarginate bulb, smooth, lutescent, pallid, reddish-brown when dry, 5-6 × 0.5 cm.

Type collected by Dr. G. F. Weber on the ground in mixed woods at Hawthorn, Fla., Feb. 16, 1941 *(F 17317)*. Not found elsewhere. Considerably darker when dry.

Mycena bambusicola sp. nov.

Pileo conico, ad 1 cm. lato, striato, squamuloso, albo, revoluto; lamellis adnexis, confertis, pallidis; sporis ellipsoideis, levibus, fulvis, 7-8 × 5 μ; stipite pallido, glabro, 4-5 × 0.2-0.3 cm.

Pileus conic to campanulate, gregarious, to 1 cm. broad in age; surface slightly viscid, striate, finely squamulose, white, dull-brownish when dry, margin entire, straight, revolute in age; context very thin, putrescent; lamellae adnexed, crowded, narrow, entire, pallid to brownish, partially dissolving at maturity; spores ellipsoid, smooth, opaque, dark-fulvous, about 7-8 × 5 μ; stipe enlarged downward, hollow, pallid, slightly darker on drying, smooth, glabrous, 4-5 × 0.2-0.3 cm.

Type collected by W. A. Murrill on dead bambo leaves under bamboo at Gainesville, Fla., June 22, 1938 *(F 17343)*. Not seen elsewhere. At first sight I thought it was a species of *Coprinus* but the spores turned out to be more like those of some species of *Cortinarius*.

Naucoria citrinipes sp. nov.

Pileo convexo-subexpanso, 1 cm. lato, pruinoso, fumoso-avellaneo; lamellis sinuatis, confertis, fimbriatis; sporis ovoideis, levibus, 6-7 × 4-5 μ; stipite citrino, strato, 2 × 0.1 cm.

Pileus convex to subexpanded, solitary, 1 cm. broad; surface dry, smooth, finely pruinose, uniformly fumosous-avellaneous, margin even, entire, deflexed; context very thin, pallid; lamellae slightly sinuate, inserted, narrow, close, fimbriate, pallid to isabelline; spores ovoid, smooth, mostly uniguttulate, pale yellowish-brown, 6-7 × 4-5 μ; cystidia none; stipe subequal, shining, citrinous, pruinose, striate, whitish-mycelioid at the base, about 2 × 0.1 cm.

Type collected by West and Murrill on decayed frondose wood in Kelley's Hammock, 10 mi. northwest of Gainesville, Fla., Aug. 3, 1938 *(F 15450)*. Not seen elsewhere.

Naucoria melleipes sp. nov.

Pileo convexo-subexpanso, 3 cm. lato, fulvo, grato; lamellis sinuatis, confertis, melleis; sporis ellipsoideis, punctatis, 7 × 4 μ; stipite fibrilloso, melleo, 5 × 0.4 cm.

Pileus convex to subexpanded with small umbo, solitary, 3 cm. broad; surface moist, opaque, fulvous, darker and much wrinkled on drying, margin incurved, even, entire; context very thin, yellowish, odorless, mild; lamellae sinuate, inserted, close, medium broad, melleous, denticulate; spores ellipsoid, slightly roughened, uniguttulate, deep-ferruginous, about 7 × 4 μ; cystidia none; stipe equal, smooth, fibrillose, melleous, 5 × 0.4 cm.

Type collected by W. A. Murrill in moss on a ditch bank in Gainesville, Fla., Jan. 1, 1940 *(F 19089)*. Not seen elsewhere. In my notes I find "Near *Flammula spumosa* but gills sinuate."

Tubaria fuscifolia sp. nov.

Pileo conico-convexo, 1-2 cm. lato, rosei-isabellino, striato, subgrato;

lamellis subdecurrentibus, latis, distantibus; sporis subovoideis, levibus, pallidis, 7-8 × 4-5 μ; stipite rosei-isabellino, 2-3 × 0.1-0.2 cm.

Pileus conic to convex, not fully expanded, gregarious, 1-2 cm. broad; surface hygrophanous, pubescent, rosy-isabelline, margin straight, striate, entire to splitting; context almost membranous, odorless, mild to slightly unpleasant; lamellae arcuate, adnate to short-decurrent, inserted, broad, distant, fimbriate, pale-rosy-isabelline when young, fuscous with age or on drying; spores subovoid, smooth, 1-2-guttulate, very pale under the microscope but bright-fulvous in mass, 7-8 × 4-5 μ; cystidia none; stipe equal, smooth, concolorous, whitish-pubescent, about 2-3 × 0.1-0.2 cm.

Type collected by W. A. Murrill in moist sandy soil in partial shade near frondose trees at Gainesville, Fla., Jan. 17, 1943 *(F 19619).* The dark gills distinguish it at once from *T. subcrenulata* Murr. Only one collection has been made to date but it contains many hymenophores.

Atylospora alachuana sp. nov.

Pileo subexpanso, 2.5 cm. lato, glabro, isabellino, striato; lamellis adnatis, latis, fimbriatis; sporis ellipsoideis, levibus, 8-9 × 4.5-5 μ; stipite glabro, pallido, 7 × 0.2-0.3 cm.

Pileus subexpanded, solitary, 2.5 cm. broad; surface dry, glabrous, uniformly pale-isabelline, margin entire, slightly striate, deflexed on drying; context very thin, pallid; lamellae adnate, plane, inserted, medium distant, broad, dark-brown at maturity with white, fimbriate edges; spores ellipsoid, smooth, opaque, deep purplish-brown, about 8-9 × 4.5-5 μ; cystidia none; stipe equal, smooth, glabrous, pallid, pale-brownish below when dry, about 7 × 0.2-0.3 cm.

Type collected by W. A. Murrill on a shaded mossy bank in frondose woods at Gainesville, Fla., Dec. 20, 1942 *(F 19895).* Not found elsewhere. Suggesting *A. australis* Murr., described from New Orleans, but not at all umbonate and having adnate gills.

Coprinus capillaripes sp. nov.

Pileo conico-convexo, gregario, 4 × 4 mm., griseo, squamuloso, sulcato; sporis ellipsoideis, 10-11 × 7-8 μ; stipite niveo, 3 cm. longo.

Pileus conic to broadly convex, gregarious, 4 × 4 mm.; surface gray, squamulose, sulcate, margin revolute; context very thin, pallid; lamellae free, rather distant, narrow, soon blackening; spores broadly ellipsoid, smooth, dark-brown, apiculate, 10-11 × 7-8 μ; stipe hairlike, smooth, glabrous, equal, snow-white, about 3 cm. long; annulus wanting.

Type collected by W. A. Murrill in an open grassy lawn at Gainesville, Fla., July 26, 1939 *(F 19975).* A very dainty little species, found but once.

Coprinus floridanus sp. nov.

Pileo convexo, gregario, 1.5-3 cm. lato, griseo aut isabellino, sulcato; lamellis adnexis, sporis ellipsoideis, 10 × 5 μ; stipite subhyalino, 4 × 0.2 cm.

Pileus broadly convex, gregarious, 1.5-3 cm. broad; surface gray or avellaneous-isabelline, isabelline on the disk, distinctly radiately sulcate, margin entire; context very thin, white, odorless; lamellae adnexed, medium broad, medium close, inserted, entire, gray when first seen, soon blackening; spores ellipsoid, smooth, black, about 10 × 5 μ; cystidia none; stipe subequal, enlarged at the very base, smooth, glabrous, subhyaline, about 4 × 0.2 cm.

Type collected by W. A. Murrill about an old stump in partial shade at Gainesville, Fla., May 28, 1938 *(F 16218)*. Found several times since in the vicinity.

Coprinus subdomesticus sp. nov.

Pileo convexo, 1.5-3 cm. lato, albo, squamuloso; lamellis adnexis, confertis, pallidis; sporis ovoideis, glabris, 10-12 × 6-8 μ; stipite albo, glabro, 1.5-3 × 0.3-0.4 cm.

Pileus convex, not expanding, scattered to somewhat gregarious, 1.5-3 cm. broad; surface white, shining, decorated with small white separable scales, becoming gray and finely striate, margin incurved and somewhat sulcate when young, becoming fimbriate or ragged; context thin, white, with pleasant flavor; lamellae tapering at both ends, just touching or free, 5 mm. broad at the middle, close, inserted, pallid to blackish, edges white, entire; spores broadly ovoid, smooth, opaque, blackish, 10-12 × 6-8 μ; stipe slightly enlarged below, exannulate, smooth, glabrous, white, base bulbous, immarginate, 1.5-3 × 0.3-0.4 cm.; universal veil breaking into small fragments.

Type collected by W. A. Murrill in open sandy soil in dry oak-pine woods near Gainesville, Fla., Mar. 15, 1940 *(F 18529)*. Found but once. *C. domesticus* Fr. is larger, with brown disk and spores 14-16 × 7-8 μ.

Psilocybe floridana sp. nov.

Pileo campanulato, 2.5 cm, glabro, melleo, amaro; lamellis adnatis, confertis, erosis; sporis 5 × 4 μ; stipite melleo, glabro, 4 × 0.5 cm.

Pileus campanulate to convex, not fully expanding, solitary, 2.5 cm. broad; surface smooth, glabrous, hygrophanous, uniformly melleous with an umbrinous tint, margin even, entire; context melleous, rather tough, very bitter at once; lamellae adnate or emarginate, inserted, medium broad, crowded, pallid with a melleous tint, eroded on the edges; spores broadly ellipsoid, smooth, uniguttulate, purplish-brown, about 5 × 4 μ; stipe cartilaginous, flattened, equal, concolorous, smooth, glabrous, 4 × 0.5 cm.

Type collected by W. A. Murrill on an oak log in low hammock at Juniper Springs, Marion Co., Fla., Oct. 13, 1940 *(F 19323)*. Not seen elsewhere.

New Combinations

For those using Saccardo the following species are recombined:

Atylospora alachuana = **Psathyra alachuana**
Galerula melleiceps = **Galera melleiceps**
Galerula parvuliformis = **Galera parvuliformis**
Geopetalum alachuanum = **Pleurotus alachuanus**
Gymnopilus fulviconius = **Flammula fulviconia**
Gymnopus amarus = **Collybia amara**
Gymnopus praemultifolius = **Collybia praemultifolia**
Gymnopus subluxurians = **Collybia subluxurians**
Leptoniella alachuana = **Leptonia alachuana**
Leptoniella floridana = **Leptonia floridana**
Melanoleuca subterreiformis = **Tricholoma subterreiforme**
Melanoleuca Watsonii = **Tricholoma Watsonii**
Monadelphus Watsonii = **Clitocybe Watsonii**
Mycena bambusicola = **Bolbitius bambusicola**
Omphalina australis = **Omphalia australis**
Omphalina brunnescens = **Omphalia brunnescens**
Omphalina fumosa = **Omphalia fumosa**
Omphalina mellea = **Omphalia mellea**
Omphalina subchrysophylla = **Omphalia subchrysophylla**
Omphalopsis pernivea = **Omphalia pernivea**
Prunulus alachuanus = **Mycena alachuana**
Prunulus subrubridiscus = **Mycena subrubridisca**
Venenarius cylindrisporiformis = **Amanita cylindrisporiformis**
Venenarius parvus = **Amanita parva**
Venenarius pseudovernus = **Amanita pseudoverna**
Venenarius Westii = **Amanita Westii**

THE BLIGHT DISEASE OF CYCAS REVOLUTA

George F. Weber

Florida Agricultural Experiment Station

A foliage disease of cycads, resulting in the usually rapid and often complete destruction of the pinnae or leaflets of the leaves in their early development, has for more than a decade been under continuous observation in Florida, particularly at Gainesville. The disease is common, and has been referred to by Bailey (1914) as a blight. Search of the literature has revealed no other reference containing a description, so that it seems advisable to make this preliminary report even though no information can be given as to the cause of the disease.

Of the numerous species of ornamental cycads grown in Florida, only *Cycas revoluta* Thunb. and *C. circinalis* L. are known to be affected by the blight. Both plants are members of the palm-like Cycadaceae, a family of plants botanically located between the cryptogams and the phanerogams. *Cycas revoluta,* probably of Javanese origin and widely disseminated from China about 1737, has the margins of the pinnae rolled under. It is the commonest cycad in cultivation, and is grown generally in all parts of Florida, although it is most frequently seen in the northern and western parts of the state because it is more resistant to cold than any of the other species. In the central and southern parts of the state *Cycas circinalis* is probably as popular; it has flat leaflets, and is a native of tropical Africa and southern Asia. The information given here pertains exclusively to the blight disease as it affects *C. revoluta.*

Diseased individuals of this plant have been found in Florida as far north as Pensacola, Tallahassee, Live Oak, Lake City and Jacksonville, and around the southern borders at Sarasota, Fort Myers, Sebring, Okeechobee and Palm Beach. No authentic reports have been found to show that the disease occurs outside the area bounded by these records, although it may possibly accompany the host plant in its distribution westward along the Gulf coast to the Mexican border and along the Atlantic coast of Georgia and South Carolina. The disease, which becomes year by year increasingly severe in affected plants, greatly reduces the ornamental value of the cycad, and usually results in removal of the diseased individuals from landscaped plantings because of their unsightly appearance and eventual death.

The earliest symptoms of the disease appear on the newly unrolled leaves, all of the 20 to 40 of which that are produced each season develop at the same time. Slightly pale-green, sunken, somewhat shrivelled marginal areas one to two millimeters in depth and twice as long appear on the pinnae of the young leaves, often when the leaves are less than one-fourth expanded, but more often about the time they have attained full expansion. The central point of each such area shows drying and bleaches to a tan color. Some shrinkage of tissue occurs along the outer margin, and the pinnae are frequently drawn up so that they curl or bend out of the more or less flat plane characteristic of healthy pinnae. The spots expand rapidly, and often involve the pinnae of the entire leaf. Color change, curling and drying proceed until the pinnae die back from half to three-fourths of their length, or sometimes almost to the rachis of the leaf. When the first symptoms do not appear until after the leaves have fully expanded the spots develop much more slowly, and may remain marginal on the pinnae so that the latter do not curl or die. In this event the spots often develop a brown or reddish-brown border, and thereafter change very little.

The causal agent of this blight disease of cycads in Florida is not known. Speculative hypotheses have indicated pathogenic bacteria or fungi, viruses and certain nutritional deficiencies. Attention given to this problem from each of these view points has not yielded conclusive evidence. Numerous attempts have been made to isolate organisms from host tissues showing first symptoms of the disease, and others at successive stages during the year, but in no instance has any bacterial organism been obtained that would produce an infection on young expanding cycad foliage. The literature examined has not revealed the name of a bacterial parasite of cycads.

The possibility of a fungus being the causal agent has not been fully explored. Stevenson (1926) has recorded foliage diseases of cycads from Italy attributed to the following fungi: *Cladosporium cycadis* Marc., *Dendrophoma clypeata* Sacc., *Hendersonia Togniniana* Poll., *Pestalozzia cycadis* Allesch., *Phyllosticta cycadina* Pass., and *Septoria Montemartinii* Poll. The following organisms have been recorded in Florida by staff members of the Plant Pathology Department of the University as associated with foliage disease of the host: *Leptosphaeria irrepta* Niessl., *Ascochyta cycadina* Scalia, *Pestalozzia cycadis* Allesch., *Rhabdospora cycadis* Kauffm., *Chaetophoma cycadis* Cke., and *Macrosporium commune* Rabh. Additional species of fungi belonging to the following

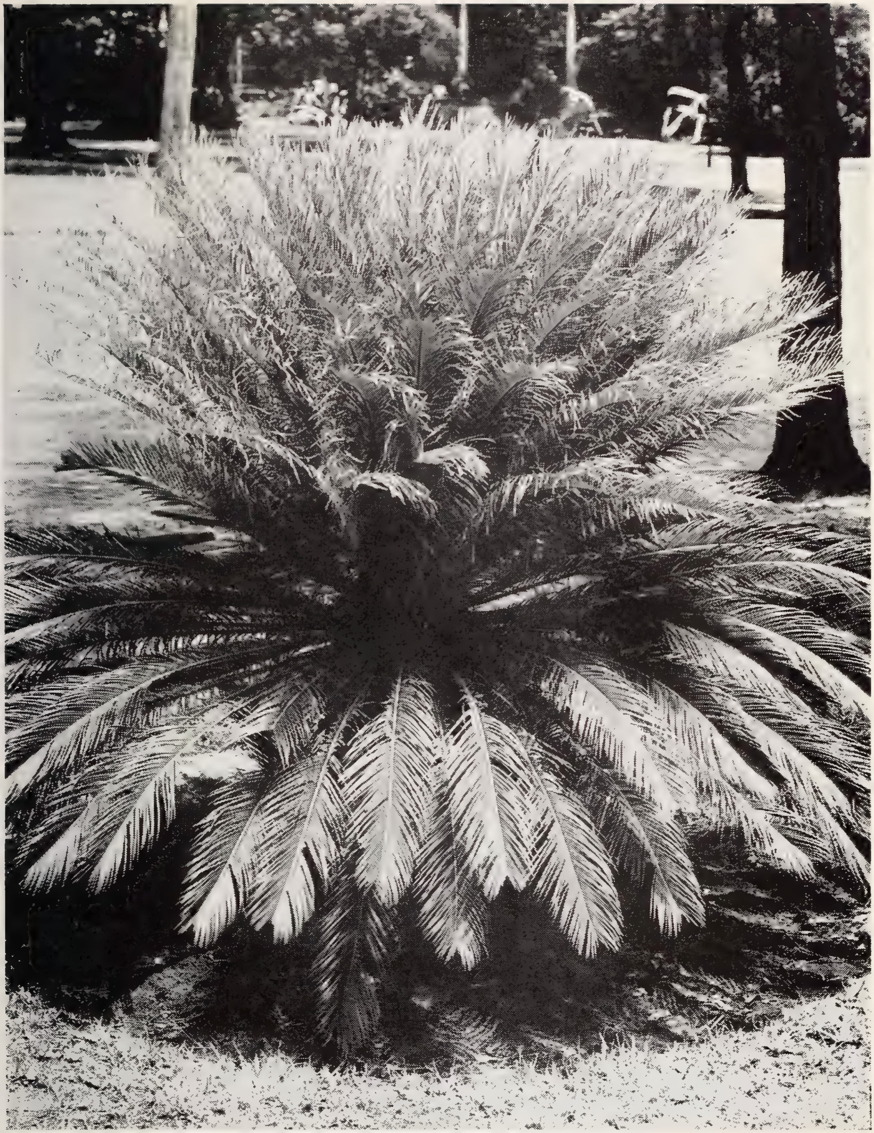

Fig. 1. Blight disease of *Cycas revoluta*.

genera have been frequently isolated from diseased foliage during the course of this study: *Botrytis, Cladosporium, Alternaria, Diaporthe, Helminthosporium, Fusarium, Glomorella, Phoma, Macrophoma* and *Pestalozzia.* Numerous inoculations were made with pure cultures of most of these fungi but no infection occurred that produced a disease similar to the blight observed in nature. Because of the lack of infection the isolated fungi were not specifically identified.

A virus has been strongly suspected and may be the causal agent, although juices extracted from severely diseased foliage have been used as inoculum in concentrations as extracted and in slight dilutions, for inoculating young plant parts by the emery dust, needle pricking and hypodermic methods without success. Insect vectors have not been thoroughly studied. Few species have been found associated with the host, and none of those insects occurring frequently on *C. revoluta* were regarded as possible carriers. Certain mineral deficiencies have been considered as the possible cause of blight. Zinc, copper, iron, magnesium, sulphur and manganese in small quantities have been applied to diseased plants as a spray or as fertilizer amendments, but these caused no visible change in disease symptoms. In this connection it should also be noted that many diseased plants have been moved from one location to another without affecting the progress of the disease.

In the Gainesville area the blight disease is most noticeable and causes the greatest damage during May and June. About this time the new whorls of leaves appear and develop. They show the disease most conspicuously, and sometimes the foliage is so completely killed that the plant may produce a second whorl within a few months, although normally only a single whorl is produced during one year. If the blight is less severe, a portion of the pinnae may survive and remain apparently free from the disease. Some lightly infected pinnae may also continue to remain green, although showing some spots or dead areas. The host plant is evergreen, retaining leaves usually for several years, so that the spotted foliage may remain on the plant while the succeeding whorl of leaves develops. After the new leaves have fully expanded and become hardened they apparently become more or less immune to further attack, as new spots are not formed, nor do old spots change greatly in size. The spotted areas become overgrown with a great variety of weak parasitic and saprophytic fungi, some of which have been enumerated. This condition continues to exist for the remainder of the year and while the next whorl develops.

Then the cycle of the disease is repeated with the newly developing leaves. The disease appears to be systemic and perennial and each year becomes increasingly more severe until the plant dies. A diseased plant has not been known to recover from the disease nor to produce a healthy whorl of leaves during any successive season. The disease is thought to be contagious because of the appearance of symptoms on previously healthy plants growing close to diseased ones, although not all healthy plants growing in such proximity have developed the disease during a ten-year observation period.

Control: Eradication of diseased plants as soon as their condition is known is the only suggestion offered at this time.

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THE PRESENT STATUS OF THE DOMESTIC TUNG INDUSTRY

FELIX S. LAGASSE[1]
Gainesville, Florida

The origin of the tung industry in the United States lay in the importation of a small quantity of tung seeds from Hankow, China in 1904 by Dr. David Fairchild of the U. S. Department of Agriculture. Test plantings indicated that the trees seemed adapted to an area about 150 miles wide extending across the Gulf States and southern Georgia, and south in Florida to the area around Gainesville.

The tung tree, *Aleurites fordii* Hemsl., is a member of the Spurge family, Euphorbiaceae, to which such plants as castor bean and poinsettia also belong. Of the five species (*Aleurites fordii, A. montana, A. cordata, A. moluccana,* and *A. trisperma*) belonging to the genus, *Aleurites fordii* is the only one grown commercially in the United States.

Tung oil is obtained from the kernels of the dried fruit. This fruit drops to the ground at maturity, usually in October, is allowed to dry somewhat in the field, and is then picked up by hand and allowed to dry to a moisture content of 12-13% to insure good milling.

There are nine mills at which the dried fruit is hulled and the oil expressed. They are located at Bogalusa, Covington and Franklinton, Louisiana; Lucedale and Picayune, Mississippi; Florala, Alabama; Cairo, Georgia; and Brooker and Gainesville, Florida. A new mill is now under construction at Capps, Florida.

The oil content of the dried fruit varies but is in general about 20%. However, from a ton (2,000 pounds) of the dried fruit, only about 320 pounds of oil (16%) is usually obtained due to milling difficulties and losses.

Since its humble start from a few imported seeds in 1904, the U. S. tung industry has developed to the stage where the value of a normal crop is roughly two million dollars, and it is still increasing. Between 1904 and 1920 most of the plantings were on a small trial scale and consisted of only a few trees. As the trees began to come into production and tests of the oil showed it to be equal to or better than the imported oil, its commercial possibilities began to be apparent. The early interest taken and assistance rendered by members of the Florida Agricultural Experiment Station made Gainesville and Florida the center of the tung industry for a number of years.

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[1] Pomologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture.

Five states—Georgia, Alabama, Florida, Louisiana and Mississippi—have approximately 99% of the tung trees in the United States, the remainder being in Texas, California and South Carolina. It is apparent from Table 1 that in 1930 Florida, then having about 85% of all the trees, was the leading state; Mississippi was second, with about 10%. By 1935, 57% of the tung acreage was in Mississippi. Although planting was continuing in Florida, it had but 29% of the total acreage, for additional plantings had also been made in the other states. Between 1935 and 1940 tremendous plantings were made in Mississippi, with the result that the total reached well above nine million trees. Large acreages were also planted to tung in Louisiana, which resulted in Florida's dropping to third place. Thus in 1940, Mississippi, Louisiana and Florida had 75, 14 and 10%, respectively, of the tung trees in the United States. Between 1930 and 1940 the industry had increased in size about 35 times, with about 13 million trees under care. This rate of development is indicative of, and a tribute to, the drive and push of the pioneers of the tung industry.

TABLE 1.—Percentages of tung trees of all ages, and of those non-bearing and bearing, in several states; and percentages of the tung crop produced in these states. (Calculated from Sixteenth Census of U.S., 1940).

STATE	All ages			Non-bearing		Bearing		Crops Produced	
	1940	1935	1930	1940	1930	1940	1930	1939	1929
	%	%	%	%	%	%	%	%	%
Georgia......	.6	5.9	.9	.6	.5	.7	16.9	1.6	2.0
Alabama.....	.8	1.8	2.5	.6	2.3	1.3	8.0	1.1	4.7
Florida......	9.6	29.3	85.8	8.9	86.0	10.9	75.1	40.0	93.2
Louisiana....	13.9	5.9	1.3	12.2	1.4	17.4	......	15.0	......
Mississippi...	74.8	56.9	9.5	77.3	9.8	69.6	......	41.9	.1
Other States.	.3	.2	......	.4	......	.1	......	.4	......

It should be stated that although the greatest number of trees has been planted in Mississippi and Louisiana, many of them are strip planted. That is, only enough land was stumped to permit cultivation of the soil immediately adjacent to the trees. This method of planting, which prevents proper care and which often results in disappointment, is no longer being practiced. It is generally conceded that the tung orchards in Florida, although less extensive, in general receive better care than those in other districts. It is of value and interest to attempt to determine why such heavy plantings have been made in Mississippi and Louisiana in recent years as compared with Florida.

EFFECT OF CLIMATE.

Temperature. It is too soon to state definitely which area will prove most suitable for tung production. However, based on past experience with damage by cold, which is one of the most serious handicaps of the tung industry, many growers feel that the Louisiana-Mississippi area is as safe as Florida, if not safer. There are of course persons who disagree with this conclusion; they claim that the Chase orchard at Lamont, Fla., is the most consistently productive tung orchard in the world. Production records for the two areas, over a period of years, must be obtained before this can be accurately determined.

Rainfall. Weather bureau records show that there are about ten inches more rainfall in the Louisiana-Mississippi area than in the Florida tung areas. This is thought by some to favor the Louisiana-Mississippi area. However, the season at which this additional ten inches of rain occurs is of great importance, as well as the relative rates of evaporation and soil moisture loss in the two areas. More information is needed with respect to these points.

EFFECT OF SOIL

Availability. It is generally agreed by all who have studied the problem that there are much larger areas of the better type soils available in the Louisiana-Mississippi area and in the North and West Florida tung areas than in Central and South Florida. The trend is definitely toward use of the better drained, heavier, more fertile sandy loams of such types as Red Bay, Ruston, Norfolk and Orangeburg, and away from the lighter, deep sands of the Blanton and Norfolk types. The Leon and associated soils are also now avoided due to poor drainage. This same preference for the more fertile types of soil is also to be noted in Florida, where the trend in planting is northward and westward from the districts where the earliest plantings were made.

EFFECT OF COST.

The cost of land has in general been less per acre in the Louisiana-Mississippi area than in Florida, due to the vast cut-over timber lands available in the former states. Largely because of this the average size of tung orchards is much greater in the Louisiana-Mississippi area than in Florida.

PRODUCTION.

That an urgent need exists to produce and conserve all of the tung oil possible is evident when one realizes that previous to the present war we imported annually from China as much as 175 million pounds. This supply has been cut off, and our needs for tung oil in war-time industries have multiplied many times. Small though it is, our domestic supply of four to six million pounds annually in good years is a welcome addition to our diminishing stockpile. Tung oil is now listed as a strategic material and is available only for essential war use. The value of a six million pound crop at the present ceiling price of 37.5 cents per pound at the mill is approximately two and one quarter million dollars. Owing to the greater average age of its trees, and also probably in part to the better care given them, Florida produced approximately 40% (Table 1) of the domestic supply of tung oil in 1940, even though at this time the state had only 11% of the bearing trees.

ECONOMIC POSSIBILITIES

So many persons have exhibited interest in the economic possibilities of tung that a few words on this point seem to be called for. The present tung industry was developed on the basis of a price of 12 to 15 cents per pound for the oil, and it should be kept in mind that within a few years after the war's end the price of tung oil will probably return to approximately this level. Under war-time conditions, all owners who have well-located, mature tung orchards are able to make a profit with the oil at 37.5 cents per pound, although owing to the present high costs of production the margin of profit is much less than might be supposed.

Under normal conditions the situation is somewhat different. Without going too far into the details of cost of production in peace time, the following figures will help to show the economic status of tung growing at normal price levels. In the past it cost 100 to 150 dollars per acre to buy and clear the land and bring an acre of tung orchard through its fifth year. After that production costs, exclusive of harvesting and milling, were roughly 15 to 20 dollars per acre. An acre of tung trees located on the most suitable soil is capable in frost-free years of producing from one to two tons of fruit per acre, from which 320 to 640 pounds of oil could be expressed. This amount of oil would have a value, at 15 cents per pound, of 48 to 96 dollars per acre. When allowance is made for reduction in yield or occasional total loss of crop from low temperatures in some years, it can readily be seen that tung growing is no easy, get-rich-quick business. However, by choosing a suitable site and soil, and with the use of selected trees and good management, it is believed possible to produce a good return on the investment.

MINERAL NUTRITION PROBLEMS IN FLORIDA TUNG ORCHARDS

MATTHEW DROSDOFF AND FELIX S. LAGASSE[1]
Gainesville, Florida

Practically all of the soils planted to tung in Florida are unable to supply to the trees the important mineral elements in amounts adequate to maintain satisfactory growth and production. The questions involved in providing the trees with these elements, economically, in sufficient quantities and in proper proportions for maximum results constitute some of the most important problems in the production of tung oil. During this present emergency the pressing need for tung oil on the one hand and the shortage of certain essential fertilizers on the other serve to emphasize the complexity of the problem.

Although it might be expected that tung trees would have the same general mineral requirements for optimum growth and production as other tree crops of the region, this is not altogether the case. For example, in certain areas in northern Florida tung trees will exhibit potassium deficiency symptoms while pecan trees receiving similar fertilizer treatment will grow normally. This would indicate that tung trees have specific mineral requirements necessitating special considerations.

Perhaps more important than this, however, is that fact that tung trees in Florida are planted on a wide variety of soils, ranging from the very light textured Norfolk sand of the central ridge section to the heavy red soils of northern Florida. This range in soil conditions constitutes an important consideration in arriving at the fertilizer requirements of the tung tree. In a sense it is misleading to speak of fertilizer requirements for tung trees without specifically indicating the particular soil conditions under which the trees are being grown. The problem of supplying mineral nutrients to tung trees growing on Norfolk sand, for example, is considerably different than with trees on Red Bay or Fellowship sandy loam.

DISTRIBUTION OF TUNG ORCHARDS IN FLORIDA

The distribution of tung orchards in Florida in a general way follows both a geographic and a soil pattern. The different areas can be conveniently grouped as follows: (1) Northern and Western Florida, (2) Gainesville area and (3) Central sandy area.

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[1] Respectively Associate Soil Technologist and Pomologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

Northern and Western Florida. Tung orchards in this area are for the most part located on well drained and aerated sandy loams. These soils generally have a sandy clay subsoil that is either yellow, brown or red or intermediate between these colors. They are classified as Norfolk, Ruston, Red Bay or closely related sandy loams and can be considered as having the best possibilities for successful tung growing. The supplementary mineral needs of trees on these soils are less than on the soils of the other sections. There are some sandy areas planted to tung in this region and the mineral nutrition problems in these areas are more comparable to those in the central sandy area.

Gainesville area. Tung orchards in this area are growing on a wide variety of soils, but for the most part they are intermediate between the northern and western Florida area and the central sandy region in their mineral requirements. Most of the soils in the area have been formed from the phosphate sandstone of the Hawthorne formation. The predominant soil types include the Arredondo and Gainesville fine sandy loams, Fort Meade loamy fine sand, and the Norfolk, Leon and Scranton fine sands.

Central sandy area. The soils in this region planted to tung trees are predominantly composed of Norfolk and closely related sands. Because of the low clay content of these soils they have the highest requirement of mineral nutrients for successful tung production. This area provides a difficult problem in economically supplying the mineral needs of the trees.

METHODS OF EVALUATING MINERAL REQUIREMENTS

A number of techniques have been used in Florida for evaluating the mineral requirements of tung trees. These are discussed briefly below.

1. *Deficiency symptoms.* If the supply of an element to the tree is too inadequate, an abnormal condition of the foliage usually develops. These leaf symptoms furnish an excellent guide for diagnosing mineral needs and in the development of intelligent fertilizer practices. It should be emphasized, however, that these symptoms develop only when the deficiency is acute. Usually the tree is retarded in growth and production before these symptoms develop. At the present time deficiency symptoms on tung foliage have been recognized for nitrogen, potassium, zinc, manganese, copper, iron, and magnesium.

2. *Leaf analysis.* The use of chemical leaf analysis correlated

with soil analysis and tree performance has come into extensive use in recent years for diagnosing mineral requirements of plants. Although leaf *symptoms* of deficiency are helpful for diagnostic purposes, they develop, as previously mentioned, only after the nutritional disorder is well established. Leaf *analysis* has the advantage in that certain mineral needs can be anticipated under different soil conditions before the appearance of any foliage abnormalities. Leaf analysis has also been particularly useful as an aid in diagnosing certain of the leaf symptoms and serves as a guide in setting up field trials to correct the disorders.

3. *Soil analysis.* This is another important and useful tool which has been used in tung investigations for arriving at a more intelligent utilization of mineral fertilizers. At present it should be considered a research tool supplementing other experimental techniques. It has been particularly helpful in interpreting the results of fertilizer experiments and as a guide for fertilizer practices in some areas. Unsolved problems in soil sampling for a tree crop, in methods of soil analysis and in interpretation of the data obtained limit the use of soil analysis for diagnostic purposes.

4. *Field experiments.* In the last analysis, the final test in the solution of any mineral nutrition problem is the response of the tree in the field to applications of fertilizer varying in amount and in the relative proportions of the constituent elements. Field trials with tung have been particularly helpful in confirming diagnoses made from abnormal appearances of the foliage and analyses of leaf and soil. The growth and production of trees in the orchard receiving differential fertilizer treatment are the most important and final criteria from the standpoint of making practical recommendations to the commercial tung grower.

Mineral Requirements in the Different Areas

This section deals with the elements that must be supplied to the tung orchard with reference to specific problems in the various areas. Although each element is discussed separately there is some necessary discussion of important interrelationships with the other elements.

Nitrogen. Nitrogen, phosphorus and potassium are the most commonly known elements used in fertilizer materials and are used in greatest amounts. In fact these elements and some form of lime were the only fertilizer materials applied to soils until relatively recently. At present, however, a number of other mineral elements have been found essential and are commonly used in fertilizers.

Nitrogen must be supplied in one form or another to all tung orchards in Florida in relatively large amounts as compared to the other elements. The tree can make little growth and will bear little or no fruit if the supply of nitrogen is low. The most characteristic symptom of nitrogen starvation is a uniform yellowing of the foliage. In acute stages a purplish coloration is evident in the petioles and on the under surface of the leaves. In general it can be said that most tung orchards in Florida do not receive an adequate supply of nitrogen for optimum growth and production. Increased applications of nitrogenous fertilizers or a more extensive cover crop program can safely be recommended for most tung orchards. Especially on the sandy soils with their low organic matter content the deficiency of nitrogen is likely to be acute.

Phosphorus. Most mixed fertilizers usually contain sufficient phosphorus to meet the requirements of the tung tree. Although this element is one of those most needed for plant growth, as yet there has been no evidence in Florida tung orchards from foliage symptoms or leaf analyses of a deficiency of this element. However, because of the high fixing capacity of the heavier soils in northern and western Florida more phosphate in the fertilizer mixture is required than in the other areas. As most of the soils in the tung orchards in the Gainesville area are derived from phosphatic materials, there has been no problem with that element in this area. Fertilizers applied to tung orchards in the central sandy section generally contain more than enough phosphate for optimum results.

Potassium. Of the three so-called primary fertilizer elements, potassium has presented the biggest problem to Florida tung growers. Extensive areas in northern and western Florida tung orchards have been found to be severely affected in growth and production because of a deficiency of potassium (Drosdoff & Painter, 1942; Painter & Drosdoff, 1943). More recently the deficiency symptoms, characterized by an interveinal chlorosis and necrosis of the foliage have also been noted in some orchards in the Gainesville area. The deficiency has occurred on soils otherwise considered well suited to tung trees and in spite of the fact that potassium has been extensively used in fertilizer mixtures. The use of a fertilizer mixture containing a high percentage of potassium as compared to nitrogen and phosphate appears at the present writing to correct the trouble, but more information on this problem is being sought by both the State and Federal experiment station workers.

Zinc. Of the so-called trace or secondary elements, zinc is the most widely needed and is used in the fertilizer program of most orchardists in Florida. The lack of zinc caused considerable loss in many of the earlier planted tung orchards until the trouble was identified (Mowry & Camp, 1934). The characteristic foliage symptoms of zinc deficiency, bronzing and malformation of the younger leaves, have been observed on tung trees on practically all of the well drained soils in Florida. Northern and western Florida soils are perhaps least susceptible to zinc deficiency, although the application of a small amount of zinc sulfate is recommended in this area as a regular fertilizer practice. The Gainesville and the central sandy sections are especially susceptible to zinc deficiency and in these areas successful tung growing is hardly possible without the regular use of zinc sulfate as a fertilizer material. Although the tree needs only a very small amount of this element, the high fixing capacities of the soils require the application of relatively large amounts of zinc sulfate. Spraying the foliage with water solutions of zinc sulfate has been successfully used by some growers. This practice requires much less zinc sulfate than do the soil applications but most tung growers are not equipped with spraying outfits and it is questionable whether the expense involved in purchasing this equipment is justifiable for the purpose.

Manganese. A partial chlorosis or "frenching" of tung leaves was found to be indicative of a deficiency of manganese (Reuther & Dickey, 1937). This disorder is not nearly so widespread or so severe as that caused by zinc deficiency. No orchards on the heavier soils of northern and western Florida have been found to be affected. Leaf analyses indicate a sufficiency of this element in that area. In the central sandy and Gainesville areas, however, many of the orchards have shown symptoms of manganese deficiency scattered throughout the planting and many growers in these areas are now regularly using manganese sulfate in the fertilizer program. In an orchard near Reddick, Florida an acute case of manganese deficiency was found and the trouble corrected by soil applications of manganese sulfate (Dickey & Drosdoff, 1943). Regular soil applications of manganese sulfate in amounts equivalent to the zinc sulfate used can be safely recommended for most tung orchards in the Gainesville and central sandy sections.

Copper. Only recently has copper deficiency been recognized as an important problem in Florida tung orchards (Drosdoff & Dickey, 1943). This deficiency is characterized by a cupping and chlorosis of the leaves and defoliation and dieback of the shoots. Parts of two large commercial orchards were first found to be severely affected by the disorder. Subsequently this deficiency was noted in other orchards. Thus far the northern and western Florida tung orchards are free of the trouble and it is not expected to show up in that area as evidenced by leaf analyses. In most of the orchards in the Gainesville and central sandy areas it is believed that small applications of copper sulfate are a necessary part of the fertilizer program. This is especially true in the areas where the deficiency symptoms have been observed.

Iron. Iron deficiency symptoms have been found in localized areas in three orchards in the Gainesville area (Dickey, 1942). Chlorosis of the leaves is the most characteristic feature of this deficiency. At the present time the trouble is not sufficiently widespread nor is enough information available to justify the use of iron sulfate in the fertilizer program except for those trees which show the symptoms.

Magnesium. Symptoms of magnesium deficiency have been observed to be widespread in tung orchards in the Gainesville and central sandy area (Drosdoff & Kenworthy, 1944). It has not been found in northern and western Florida. A marginal necrosis of the leaves occurring late in the season is the most characteristic feature of this deficiency. Some orchards have been so severely affected as to cause considerable concern to the grower. As yet neither magnesium sulfate nor any other magnesium carrying fertilizer has been used in commercial tung orchards but the widespread appearance of the symptoms will necessitate the use of some form of magnesium in the fertilizer program of affected orchards. Experimental work has not proceeded far enough to warrant any recommendations except to state that large applications of magnesium sulfate over a two-year period corrected the disorder on severely affected 7 to 10-year-old tung trees.

SUMMARY

Experience and research have shown that practically all of the soils in Florida on which tung trees are planted require additional amounts of some of the mineral elements to maintain satisfactory growth and production.

The tung areas in Florida follow, in a general way, both a geographic and soil pattern and can be grouped as follows: (1) Northern and western Florida, (2) Gainesville area, (3) Central sandy area.

The several methods used in evaluating the mineral requirements of tung trees have been: (1) Consideration of the deficiency symptoms or abnormal leaf patterns. (2) A comparison of the analyses of normal and abnormal leaves. (3) The use of soil analyses within its recognized limits. (4) The establishment of field experiments in which varying amounts and different proportions of the mineral elements are supplied to the tung trees.

Additional amounts of nitrogen are needed in all three of the above areas. No deficiency of phosphorus has as yet been observed or recognized on tung trees in Florida. A severe potassium deficiency was found to exist in extensive areas in northern and western Florida tung orchards.

Of the trace or secondary elements, zinc is most widely needed in supplemental amounts and is supplied as zinc sulfate.

The lack of sufficient manganese also causes a partial chlorosis that can be readily corrected with manganese sulfate.

A deficiency of copper results in a cupping and chlorosis, defoliation of the leaves and dieback of the twigs. Copper sulfate applied to the soil or as a spray to the foliage corrects the difficulty.

Iron deficiency symptoms have been observed in limited or localized areas and were corrected by the application of iron sulfate.

Symptoms of magnesium deficiency have been observed in the Gainesville and central sandy areas. Application of magnesium sulfate over a two-year period corrected the disorder.

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THE PLACE OF CENTRAL DISTILLATION IN THE NAVAL STORES INDUSTRY

JOHN O. BOYNTON
Havana, Florida

Central distillation is a new phrase in the naval stores industry —one less than fifteen years old. It means simply that operators or producers of gum sell their product as gum instead of themselves processing it into turpentine and resin. Before 1930 such a procedure was not possible, because there were no central stills. A central still is a distillation plant erected in a location central to a large volume of gum production. It depends for its success upon the willingness of the producers to sell their gum rather than process it themselves.

The idea of central distillation originated with W. J. Boynton in 1927, when he and his brothers were operating five still sites in as many directions from Tallahassee.[1] In its inception it was to be simply a central plant in Tallahassee to which all the gum from the five operations would be hauled. By 1930 the idea had expanded to include stilling for other producers for a fee, and by 1933 it reached maturity with the straight purchase of gum from producers at a price based on its turpentine and rosin content and rosin grade.

Shortly after 1933 the Glidden Company erected a central distillation plant in Jacksonville. The idea for this plant was probably entirely independent of the Tallahassee development, and grew out of the company's need for a regular and assured supply of turpentine and rosin, and possibly because its need for a particular grade and class of rosin. By 1935 the Peninsular

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[1] Consultation with J. E. Hawkins of the Department of Chemistry, University of Florida (engaged in naval stores research), G. P. Shingler, Chemist in charge of the Naval Stores Research Station at Olustee, Florida and L. A. Goldblatt, Acting Chief of the Naval Stores Research Division, Bureau of Agricultural and Industrial Chemistry, U. S. D. A., at New Orleans, revealed no knowledge by any of these men of any central distillation project prior to that mentioned. Mr. Goldblatt, however, commented as follows (letter, August 9, 1944): "I infer that the specific question involved is the one of priority for central stills. This would depend upon one's definition of the terms central still and central distillation with respect not only to mode of operation, but also to facilities provided. Of course, in the narrowest sense, the first person who ever bought a barrel of gum for distillation could consider himself the original operator of a central still. I do not have any personal explicit knowledge of the existence of central stills prior to those discussed by Mr. Boynton." —Editor.

Lurton Company of Pensacola was toying with the idea of central distillation, and the Rosa Company had begun operations in South Georgia.

During this time and until 1940 factorage houses bitterly opposed the development of central distillation, frequently forbidding operators who were under financial obligations to them to sell gum to central plants. Their reasons were simple—just a matter of dollars and cents. Factors were losing plenty of potential profits for every operation that began using the new facility. Since they could not safely state the real grounds for their objection, they claimed that it affected the market adversely, since a true picture of supply and demand could not be developed when so much of the production did not go over the regular market board.

Such is the history of most changes, however, and opposition from those who stand to lose by the change cannot long delay the inexorable march of progress. Today only one factorage house of importance has failed to enter central distillation. Being unable to block the progress of this development, they have bought interests in existing plants or built competing ones.

There were many obstacles to be overcome in the early years of central distillation. Boynton's still in Tallahassee could not have sustained itself had not the volume of gum which the company's own operations produced been sufficient to warrant it. As these operations for gum production grew less the volume from surrounding producers increased. Owners of small tracts of woodland began working their own timber rather than leasing the right to old-line operators. So profitable did these ventures prove that news of their success spread rapidly. More and more gum began to come in. By 1935 Boynton had completely abandoned gum production and was concentrating entirely on buying gum from producers.

The radius over which gum flowed in began to increase. Better roads were coming fast, and the year 1942 saw several operations sending gum from 150 miles away. One operator within 25 miles of Gainesville has hauled to Tallahassee for three years. Producers who had to abide by the dictates of a factorage house because of financial obligations, bent every effort toward freeing themselves from such restraint. Many of them have done so and now sell gum to central stills. Many operators were slow to believe that more net profit could be realized by this procedure than by the old method of processing and selling through a factor. Most of them are now convinced and are selling gum.

Early in the history of central distillation the naval stores station at Olustee became interested in the idea and convinced that the future of the industry lay in that direction. An improved method of still-setting for the producer-processer had been devised by Messrs. Shingler and Reed, and naval stores technologists (of whom I was one) were furnished to supervise the construction of stills by the improved method. The station then set to work to devise a system of cleaning gum which would be suitable for use at central stills. Much progress has been made along these lines. Many of the central stills have used ideas obtained from the experiment station, and two have used the plans of the station equipment outright. More progress may yet be expected, both in cleaning gum and in distilling it.

The chips from the government method are clean and dry. The chips from the old fire-still process are covered with their weight of rosin, which is a total loss. The rosin from the government process is so clear that printing can easily be read through it. The rosin made by the old method is so filled with impurities that printing can be read through it with difficulty. The crude gum, opaque and full of chips, is in strong contrast to the clear liquid which is the cleaned gum.

Briefly, here are the reasons why central distillation of pine gum is destined to be the only method employed in the future:

1. Within a few years all operations are going to be small, since the large unbroken tracts of timber will be depleted. Small operations cannot afford the expense of stilling.

2. Highway transportation makes delivery of gum to a central still more convenient than delivery of the finished product to a factor.

3. Timber owners have learned they can pay double the prevailing wage to turpentine labor and still clear three to four times what they once obtained as lease price from operators.

4. Federal financial aid for proper working of timber is an added inducement for a man to operate his own timber and protect it from fire, thus insuring a better yield of gum, a faster growth of timber, a thicker stand of new trees, and an ever-increasing supply of gum for the still and of revenue for himself.

5. Competition from wood-rosin makers is forcing gum-rosin producers to standardize and to advertise a standard product. This can be done only at central stilling establishments.

6. The inevitable rise in standards of living will make the old cheap labor operation impossible in the southland of tomorrow.

7. Central stills, with hundreds of barrels of gum, can so blend their still charges as to produce any desired grade of rosin. Under old conditions the rosins made were just what happened to come out of the tail-gate. Today they are what is deliberately and scientifically put in the charging cap.

MULCHES TO CONTROL ROOT-KNOT

J. R. WATSON
Florida Agricultural Experiment Station

Root-knot, easily the most serious disease of vegetable crops in Florida, has for many years been receiving a large part of the attention of the Department of Entomology of the University of Florida Agricultural Experiment Station. This nematode-caused disease is present in practically all sandy land in Florida which has been under cultivation for any considerable time. It attacks most garden and vegetable crops, a great many herbaceous ornamental plants, many shrubs including roses and pittosporum, and a considerable number of trees including peaches and mulberries.

Heavy mulching of susceptible plants is among the methods of control which we have developed and advocated. It is particularly important in the culture of perennial plants such as peaches, roses and pittosporum, and is also very effective on many tall-growing annuals, for instance okra. We have also successfully used a heavy mulch on peas, papayas, squash, lettuce, and a variety of other plants.

A wide assortment of materials has been tried for the mulch, including paper, grass, leaf debris from the forest, water hyacinths from ponds and lakes, crotalaria stems, and many other things. The use of paper mulch has not been very successful, but any vegetable material that will decay has proved very beneficial and has been effective for some time after the removal of the mulch. In all instances, mulched plots have shown much better growth than was obtained on unmulched check-plots. Okra, which is one of the most seriously affected of our truck and garden crops and in unmulched check-plots is quickly killed, usually before producing pods, makes good growth and produces a satisfactory crop when mulched. This practice has uniformly resulted in better growth of most plants, both out-of-doors and in pots in the greenhouse where our experiments are continued during the winter[1].

A puzzling feature of the situation is that the plants grown in mulched plots or pots, although healthy, usually have fully as many knot-galls on their roots as do the weaker unmulched control plants. Of course, we never expect complete elimination of any pest or disease by biological means[2], and it is therefore not surprising that root-knot is still present in the mulched plants. What is remarkable is that the plants are so increased in vigor by mulching, without any apparent reduction in the amount of nematode infestation. The mulched plants do, however, have more good healthy roots than the unmulched ones. The result is evidently not due simply to shade, since mulch paper does not prove effective. Nor—although the decaying mulch undoubtedly supplies food to the plants—can it be accounted for solely by increased fertilization, since plants in the check plots and pots supplied with an abundance of fertilizer showed no such response. Nor can the effect of the mulch in reducing water loss from the soil and thus minimizing the bad effects of drought be the factor responsible. It is true that plants suffering from drought are always more seriously affected by the presence of root-knot than are those with plenty of moisture; but the soil in the check plots and pots was never allowed to become dry.

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[1] The root-knot nematode is relatively inactive out-of-doors from November 1 until April.

[2] The most thorough biological control that has ever been attained is apparently that of the cottony cushion scale by the Australian lady beetle. Even here the result, although commercially satisfactory, is not 100% destruction of the scale insect.

What, then, does cause the increased vigor and growth of mulched plants as contrasted with the controls? Workers in Hawaii have suggested that it is the growth of fungi in the mulch that is responsible, and some European observers have actually seen fungous hyphae penetrate the bodies of root-knot nematodes. But if killing the nematodes by fungi is the explanation, how is one to account for the presence of so many galls on the roots of the mulched plants? Is it not possible that the mulch adds some material to the soil, aside from fertilizer, which stimulates the growth of plants?

A strong hint that the mulch does provide some such growth-producing substance other than fertilizer is given by the results of experiments on tomatoes and okra carried out during 1942-43. Four sets of pots were used; one set was mulched, another was well fertilized but not mulched, a third was watered with an infusion obtained by soaking mulch-material in a bucket of water, and a fourth was watered with the same amount of tap-water. The mulched plants made the best growth, although the amount of mulch material in each pot was small, the pots being only eight inches in diameter and the depth of the mulch one or two inches. The plants watered with the mulch infusion made the next best growth; those which were fertilized but neither mulched nor watered with mulch infusion were severely injured and did rather poorly; and the unmulched plants which received neither mulch infusion nor fertilizer all died without getting more than a few inches tall or producing any crop. Further experiments are planned to try to find out how the mulch protects plants from the effect of the nematodes.

Whatever the explanation may be, the fact seems clearly demonstrated that a mulch gives a remarkable degree of protection from root-knot.

Besides its importance in the culture of perennial plants such as roses, pittosporum and peaches, it is especially valuable to the back-yard gardener. It conserves moisture and makes plants better able to withstand drought; it adds plant food to the soil; it reduces the amount of cultivation necessary and helps to prevent the growth of weeds—especially nut-grass, Bermuda, and other grasses. If thick enough the mulch will destroy nut-grass by shading. A disadvantage of mulching, of course, is the interference with cultivation, which limits its usefulness in large-scale truck-farming. Another disadvantage, especially in respect to truck-farming, is that it tends to increase the susceptibility of plants—especially those that are low growing—to frost injury, since frost forms more abundantly on straw and ground litter than on the surface of bare ground. On the other hand if the mulch can be pulled over the plants on cold nights it gives them considerable protection from cold.

In view of the importance of mulch for controlling root-knot and as a fertilizer and moisture-conserver, the burning of grass and weeds almost universally practiced by town-dwellers is extremely wasteful. If property owners in towns cannot themselves use this material as mulch for their vegetable gardens, on flower beds, or around shrubbery, and must dispose of it in some way, the municipality should itself conserve it. The heaps of grass, leaves and other vegetable trash should be collected, piled in some out-of-the-way spot where the material can be allowed to decay, and placed under the care of someone who knows how to handle mulch. It can then be used in the city parks or sold to gardeners. The fertility of the soil is one of the things that we must learn to conserve and pass on to succeeding generations, and the practice of mulching is one of the best but at present least used means of doing this.

A STUDY OF QUAIL FOOD HABITS IN PENINSULAR FLORIDA

Albert Middleton Laessle
University of Florida

Knowledge of quail food habits is not only essential for understanding the ecology of this bird, but is also basic to any intelligent planning for its conservation. Although a very extensive and excellent food study was included by H. L. Stoddard in his classic work, "The Bob-white Quail: Its Habits, Preservation and Increase" (1936), Stoddard's data from analysis of crop and gizzard contents were nearly all obtained in regions north of peninsular Florida, the southernmost being from fifteen birds taken in the vicinity of Gainesville, Florida. S. D. Judd (1905) studied crops from thirty-nine Florida quail, but all of these were from the western part of the state. Since the food habits of any such widespread species as the bob-white quail will almost inevitably differ from region to region, with the change in natural vegetation, the investigation upon which this paper is based was undertaken to increase our meagre knowledge of the food habits of quail in peninsular Florida.

Although peninsular Florida lies entirely in the coastal plain, a province well covered by Stoddard's work further north, the flora of the peninsula differs markedly from that of the rest of the coastal plain. In spite of its slight elevation and relief, the highest point being barely over three hundred feet above the sea, Florida possesses a wide variety of soils with which are associated characteristic types of vegetation. Certain of these plant associations (sand scrub, tropical hammock, etc.) are distinctive of the peninsula. Other more widespread habitats, such as flatwoods, sandhills, non-tropical hammocks, etc. differ from one region of the state to another, and in Florida as a whole compared with other parts of the coastal plain. It is evident, therefore, that the environments and food habits of quail in peninsular Florida are not necessarily the same as in even so near a region as Florida north of the peninsula.

I am indebted to Dr. J. Speed Rogers, of the Department of Biology, University of Florida, whose aid was invaluable in planning and carrying out the studies which form the basis of this paper. I am very grateful to Dr. T. H. Hubbell, of the same department, for the identification of nearly all of the animal matter and for his preparation of a list of all species of insects recorded in this work. Dr. F. N. Young was helpful in determining Coleop-

tera and snails. Mr. Erdman West and Miss Lillian Arnold, both of the University of Florida Herbarium, generously made the Experiment Station seed collection available for comparisons. Drs. A. F. Carr and H. L. Knowles, and Messrs O. E. Frye, J. S. Rogers Jr., Fred West, T. R. Young, Lewis Marchand, and A. W. Brown all aided by contributing quail crops.

The principal habitats from which the material for this study was obtained are the sandhills, the flatwoods, and to a lesser extent the hammocks. These are, in fact, the chief habitats widespread throughout peninsular Florida in which quail typically occur. Another more local and distinctive habitat is the rocky pineland found in the southern East Coast region, extending from just north of Miami southwest to Royal-palm Park. All of these habitats are much modified floristically where agriculture is or has been recently carried on.

In general the *sandhills*[1] exhibit a rolling topography; in places they are low, with gentle slopes, elsewhere steep-sided and of considerable height. Most sandhill soils belong to the Norfolk Series[2]; they are well drained and rather poor in soil nutrients. The dominant trees on such areas are longleaf pine (*Pinus australis*)[3], turkey-oak (*Quercus laevis*), blue-jack (*Quercus cinerea*), and small post-oak (*Q. Margaretta*).

Flatwoods of the peninsula occupy level terrain. The soil texture is sandy; poor drainage, with hardpan within a few feet of the surface, is characteristic of the soils of most of this habitat. At least three-quarters of the flatwoods soils belong to the Leon Series. Long-leaf pine (*Pinus australis*), slash-pine (*Pinus palustris*), and in the moister parts, pond or black-pine (*Pinus serotina*), are the dominant trees.

The *rocky pinelands*[4] of the southern East Coast have a soil composed of a shallow covering of sand with oolitic limestone outcrops nearly everywhere. The land is rather flat and low, twenty feet above sea level being considered high. Low areas with marl soil occur in small strips between the higher pinelands. These marl areas are largely planted to winter vegetables, but after the winter crops have been harvested are usually occupied by ragweed

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[1] This "habitat" is approximately synonymous with "high pine woods" Watson (1926), "longleaf pine—turkey-oak," Society of American Foresters (1932), "high-pine," Carr (1940), etc.

[2] Henderson (1939).

[3] All plant names used in this paper follow Small (1933).

[4] Other authors include the *flat, rocky pinelands of Southern Florida* under the term "flatwoods."

(*Ambrosia sp.*). Caribbean-pine (*Pinus caribaea*) is practically the only tree in the pinelands. Many plants which normally reach tree size in the nearby semitropical hammocks, occur in these pinelands only as shrubs. Among the more prominent of these are poison-wood (*Metopium toxiferum*), fiddle-wood (*Citharexylum fruticosum*), florida-trema (*Trema floridana*) and gumbo-limbo (*Elaphrium Simaruba).* Other characteristic shrubs are saw-palmetto (*Serenoa repens*), silver-palm (*Coccothrinax argentea*), a dwarf lantana (*Lantana depressa*), snowberry (*Chiococca pinetorum*), a perennial partridge-pea (*Chamaecrista Deeringiana*), a croton (*Croton linearis*), christmas-berry (*Rhacoma ilicifolia*), a gopher-apple (*Geobalanus pallidus*) and a runner-oak (*Quercus succulenta*). Prominent herbaceous plants are *Galactia pinetorum,* panic-grasses (*Panicum* spp.), *Paspalum* spp., nut-rushes (*Scleria* spp.), *Stillingia angustifolia, Tragia spp., Tithymalopsis Curtissii, Piriqueta* spp., *Melanthera* spp., and *Jacquemontia* spp. Little of the rocky pineland is cultivated except in the Redlands district.

Quail are, and no doubt originally were, plentiful in these rocky pinelands. The drainage and agricultural development of the surrounding marl lands, formerly dominated by swamps of saw-grass (*Mariscus jamaicensis*) and pond-apple (*Annona glabra*), have been steadily enlarging the area favorable to quail.

The *hammocks*[5] from the southern end of the lake region northward have a flora much more similar to that of the coastal plain north of peninsular Florida than they do to the semi-tropical hammocks of the southern end of the state. Broad-leaved evergreens are the dominant trees—live-oak (*Quercus virginiana*), laurel-oak (*Q. laurifolia*), bull-bay (*Magnolia grandiflora*), red-bay (*Tamala Borbonia*), American-holly (*Ilex glabra*). Common deciduous trees of the hammocks are hickories (*Hicoria* spp.), sweet-gum (*Liquidambar Styraciflua*), hop-hornbeam (*Ostrya americana*), red-oak (*Q. rubra*), flowering-dogwood (*Cynoxylon floridum*).

METHODS

A seed collection to be used for comparison with seeds found in quail crops was begun during the fall of 1936. Additions were made to this collection throughout the period of study until about five hundred species of plants were represented. Any seeds that seemed likely to be eaten by quail were collected. All collections and identifications of seeds were made by me from plants under observation in the field.

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[5] Laessle (1942) restricts the term "hammock" to mean only plant communities dominated by broad-leaved evergreen trees, growing on land not subject to inundation.

Of the two hundred birds taken, one hundred and eight came from Alachua County, seventeen from Polk County, fifteen from Dade County, twelve from Orange County, eleven from Seminole County, seven from Hillsborough County, six from Putnam County, and twenty-four from "central Florida" with no record as to county.

With permission from the Florida Fish and Game Commission, forty-eight birds were shot by me during the spring and summer of 1938. Only four of these out-of-season birds were females, these having been shot by mistake. Nearly all the others were unmated cocks, which were called up within shooting distance by imitating the female call.

Records of sex, weight, date, habitat, county, and time of day shot were made for all birds personally collected. About one hundred crops taken during the hunting season were given to me by hunters. Date, county, and habitat were known on all of these except twenty-four which were shot in central Florida during the winter of 1938-39. Most of the birds which I collected were shot late in the day because their crops usually contain more at that time. Only two of the crops examined were empty or nearly so. Both crops and gizzards of all birds shot by myself were preserved in a 10% solution of formaldehyde, while of the birds shot by others only the crops were thus preserved for future study.

Crops and gizzards were examined separately. Their contents were completely removed and put into a shallow white dish with a convenient amount of water. Animal matter was first picked out with forceps, preserved in weak formalin and placed in a vial with proper catalogue number. Later, after determination, this material was air dried and weighed. Seeds, plant fragments and grit were separated into piles and dried. After drying, these items were identified as far as possible, counted, weighed and put into envelopes with a catalogue number. Oak galls were considered plant rather than animal matter.

Difficulty was experienced in determining many seeds such as sand-peas (*Cracca* spp.), milk-peas (*Galactia* spp.) and panic-grasses (*Panicum* spp.) farther than to genus. Much green matter composed of leaf fragments and small seedlings was determined to genus. One crop was nearly filled with young wild-grape seedlings. Leaves of wood-sorrel (*Xanthoxalis* sp.) and very young seedlings of pine and of partridge-pea (*Chamaecrista* spp.) were observed on numerous occasions.

Because the gizzard is a selective organ, tending to retain hard seeds and insect parts much longer than soft materials, I believe that data from crops alone give a more accurate idea of the proportions of the foods eaten than would the inclusion of data from gizzards as well. Gizzards were examined only to give data on the *kinds* of plants and animals eaten. All *proportions* in this study are based on crop contents only. Proof that the gizzard is selective was furnished by the fact that fragments of magnolia seeds[6] were found in nine gizzards while only one crop contained any, although more material was generally present in the crops. These fragments from the gizzards were much worn and must have been there for many days.

Although it has been common practice to base the proportions of the various components of the food on volumetric measurements[7], it seems to me that proportions based on dry weight are at least as appropriate and that they give a more accurate idea of the amount of food value contained, since most of the water is thus eliminated. In most insects, fleshy fruits, and leaves, a considerable amount of water is lost in drying. In most legumes and in hard-coated seeds very little water is lost in the drying process, unless they are swollen, which is very often the case. Swollen seeds were generally three or four times the volume of unswollen seeds of the same species. Air-drying reduced all seeds of a given species to about the same size and weight.

TABULATION AND DISCUSSION OF DATA

TABLE I.—SEASONAL PERCENTAGES BASED ON DATA FROM ALL CROPS, REGARDLESS OF THE HABITAT OR COUNTY.

	Spring	Summer	Fall	Winter
Plant matter *	78.6	76.8	93.3	99.0
Animal matter	21.4	23.2	6.7	1.0

*Excluding leaf-fragments, which are not considered a critical factor this far south.

"Spring" includes April, May and June; "summer" includes July, August and September; "fall" October, November and December; and "winter" January, February and March. The data for spring are based on twenty-six crops, those for summer on twenty-two, for fall on ninety-six and for winter on fifty-six. Owing to the fact that about three times as many crops are represented in the fall and winter data, yearly percentages were calculated by adding the percentages for all seasons and dividing by four. This method gives a yearly total of 86.03% plant food and 13.97% animal food.

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[6] Stoddard (1936) found much-worn fragments of magnolia seeds in the gizzards.

[7] Martin and Uhler (1939) state that "volumetric percentage is regarded as the most significant index of food value . . ."

The small amount of animal food eaten during the fall and winter seems readily explained by the seasonal nature of the insect supply. However, it also appears likely that, inasmuch as high-protein seeds are most available during the fall and winter, their scarcity during the spring and summer is a factor that would tend to force the quail to substitute insects for the seed diet which they prefer. This hypothesis is given greater weight by the fact that the few gravid females taken had all eaten an unusually high percentage of animal matter. Since birds in this condition must eat much more, it seems likely that, if only a limited amount of suitable plant food were available, any insufficiency would have to be made up by animal material. It was also noticed that gravid birds had eaten an unusually large proportion of shelled snails—possibly to supply the calcium necessary for egg-shell formation.

TABLE II.—PERCENTAGES OF IMPORTANT PLANT MATERIALS EATEN, SHOWING SEASONAL OCCURRENCE IN THE SANDHILLS.

	Spring (13 crops)	Summer (7 crops)	Fall (69 crops)	Winter (39 crops)
Acorns	4.92	22.81	26.3	8.33
Ragweed (*Ambrosia* spp.)	0	0	7.04	.01
Bivonea stimulosa	57.78	.56	0	0
Partridge-peas (*Chamaecrista* spp.)	.23	0	16.27	22.75
Milk-peas (*Galactia* spp.)	0	24.6	17.09	28.34
Gopher-apple (*Geobalanus oblongifolius*)	0	0	.75	17.54
Summer-farewell (*Kuhnistera pinnata*)	0	0	.47	7.17
Panicum spp.	2.46	1.31	2.23	.15
Rhynchosia spp.	3.71	13.76	4.58	.93
Nut-rushes (*Scleria* spp.)	27.77	.03	.01	.01
Finger-grasses (*Syntherisma* spp.)	.03	22.44*	.88	.05
All others	3.1	14.49	24.38	14.27

Discussion of Table II: Field observations lead me to believe that desirable quail foods are scarce in the sandhills during the spring, especially in the early part. At this time of the year variety of food is also limited in this habitat. Table II shows that about eighty-five percent of the plant food taken the spring was made up of only two items. No doubt more variety would be shown if

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*Almost all from one crop which was nearly filled with the seeds of *Syntherisma Simpsoni.*

more crops had been examined from this habitat and during this season. The high percentage of acorns occurring in the summer crops is probably due to the fact that all of these birds were obtained late in September. It was surprising to find large numbers of gopher-apple seeds in the winter crops, since the fruits ripen in the summer. This discrepancy is probably to be accounted for by the fact that, well up into the winter, many of the weathered pits of these fruits are scattered about the mouths of gopher-turtle burrows. The fruits of the gopher-apple are relished by the turtles, but the seeds are not digested by them. Thus their abundance about the burrows and their common occurrence in the quail diet at this season may be plausibly explained.

TABLE III.—PERCENTAGES OF IMPORTANT PLANT MATERIALS EATEN, SHOWING SEASONAL OCCURRENCE IN THE FLATWOODS.

	Spring (12 crops)	Summer (no crops)	Fall (20 crops)	Winter (7 crops)
Acorns	0	no data	6.98	.85
Wax-myrtle (*Cerothamnus* spp.)	.01	no data	0	17.94
Partridge-peas (*Chamaecrista* spp.)	13.06	no data	13.72	63.66
Galls (oak)	0	no data	8.90	.02
Milk-peas (*Galactia* spp.)	3.15	no data	.07	3.02
Blueberries*	56.29	no data	0	0
Panicum spp.	12.49	no data	40.33	.06
Pines (*Pinus* spp.)	.11	no data	12.49	.44
All others	14.89	no data	7.51	14.45

*Includes *Cyanococcus*, *Decachaena* and *Lasiococcus*.

Discussion of Table III: A number of discrepancies are apparent in this table, probably on account of the small number of crops taken from the flatwoods. It seems likely that a considerable quantity of seeds of wax-myrtle (*Cerothamnus* spp.) is eaten in the fall, although none was found in the crops obtained at that season. The large amount of panic-grass (*Panicum* spp.), shown for the fall is due mostly to the fact that three full crops, obtained from one covey, were almost entirely filled with the seeds of *P. verrucosum*. One of these crops contained 4.11 grams, or an estimated four thousand of these small seeds.

The accompanying photograph (Fig. 1) shows all the seeds and fruits found in the crop of a gravid female from the flatwoods habitat. In addition to the plant material shown, this crop contained the following animal material (figures in parentheses indicate the number of individuals of each species eaten).

MOLLUSCA: *Polygyra* sp. (13), *Planorbis* sp. (1).
CHILOPODA: Scolopendridae (3).
DIPLOPODA: Polydesmidae (2).
ARACHNIDA: small Attid spider (1), small spider (1).

INSECTA

ORTHOPTERA

Phasmidae: *Anisomorpha buprestoides* (Stoll.), (3), and one egg of same.

Acrididae: *Melanoplus rotundipennis* (Sc.), (2), juv. *M. keeleri keeleri* (Thos.), (1), juv. *Melanoplus* sp. (11), juv. *Gymnoscirtetes pusillus* Morse, (1), *Orphulella pelidna* (Burm.), (1), *Aptenopedes aptera borealis* Hebard, (1).

Tettigoniidae: juv. *Odontoxiphidium apterum* (2), juv. *Amblycorpyha* sp. (1), juv. *Scudderia* sp. (1).

HOMOPTERA: *Phylloscelis atra albovenosa* Melichar (1), *Hysteropterum punctiferum* Walker (1), *Oncometopia lateralis* (Fab.), (1), *Draeculacephala 7-guttata* Walker (1), *Gypona* sp. (2), *Jassus* sp. (2), small Fulgorids (2).

HEMIPTERA: *Euschistus ictericus* (Linn.), (4), *Mormidea lugens* Fab., (1), adult and (8) juv., juv. Pentatomids (3), juv. *Corimelaena* sp. (1), hemipterous eggs (13).

COLEOPTERA

Curculionidae: *Pachnaeus opalus* Ol., (4), undetermined Curculionids (9).

Crysomelidae: *Oedionychis* spp., (3), *Disonycha* sp. (1), *Tymnes* sp., (1) *Cryptocephalus* sp., (1), large pupae (4).
Scarabaeidae: *Diplotaxis* sp., (1).
Buprestidae: *Chrysobothris* sp., (1).
Elateridae: *Melanotus* sp., (1).
Histeridae: *Gnathoncus* sp., (1).
Staphylinidae: fragments.
Coleopterous larva (1).

LEPIDOPTERA: *Basilarchia* (?) caterpillar (1), medium sized larva (1).

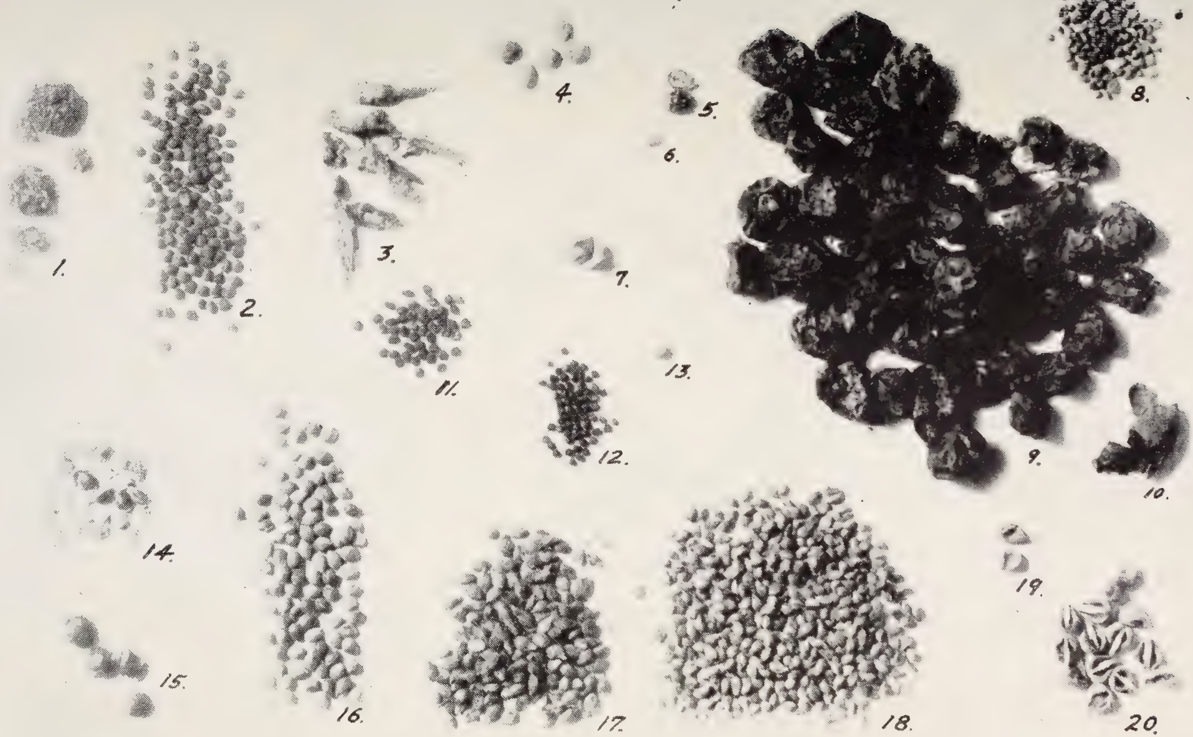
HYMENOPTERA: Ants, *Camponotus* sp. cf. *caryae* (7), *Camponotus* sp., (8).

VERTEBRATA

AMPHIBIA: medium-sized frog, *Hyla femoralis* (1).

Figure 1. Showing all seeds and fruits found in the crop of a gravid female quail shot in the flatwoods near Gainesville at 6:15 P.M., May 10, 1938. About one and one-half times natural size.

(1) *Decachaena tomentosa;* (2) *Hypoxis* sp. (free seeds); (3) *Hypoxis* sp. (capsules); (4) *Commelina* sp.; (5) *Stylosanthes* sp.; (6) undetermined; (7) *Tragia* sp.; (8) *Cyanococcus Myrsinites* (free seeds); (9) *Cyanococcus Myrsinites* (whole fruits); (10) *Pinus palustris;* (11) *Hypoxis* sp.; (12) *Hypoxis* sp.; (13) undetermined; (14) *Scleria* sp.; (15) *Scleria* sp.; (16) *Viola* sp.; (17) *Panicum* sp.; (18) *Panicum* sp.; (19) *Cerothamnus* sp.; (20) Rubiacious seed.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Quail food appeared to be more plentiful in the flatwoods than in the sandhills during the spring months. Areas of flatwoods containing many birds in the spring were observed to contain very few in the fall. Nearby sandhills, on the contrary, showed evidence of the presence of but few birds in the spring, but quail were plentiful there in the fall. These observations lead me to believe that where flatwoods and sandhills are close together, seasonal migration of quail to and from these habitats is a general occurrence. It seems likely that such movements are caused mainly by seasonal variations in the amounts and variety of suitable plant foods in these two habitats. Another factor which may help to bring about such movements is the late winter burning to which the flatwoods is frequently subjected. The ground cover in the flatwoods is often too dense for quail, especially in the moister parts. The winter burning removes much of this vegetation, and makes the flatwoods favorable for the birds during the spring. By fall the ground cover is again too thick, and this causes a return migration to the sandhills, where the undergrowth is seldom too heavy. The occurrence of such seasonal movements agrees with and helps to explain the basis for the generally accepted belief that a given area of land with diversified habitats will support more quail than an equal area that is relatively uniform.

TABLE IV.—PERCENTAGES OF THE PRINCIPAL PLANT MATERIALS EATEN IN THE HAMMOCKS (exclusive of the semi-tropical hammocks of southern Florida).

Sweet-gum (*Liquidambar Styraciflua*)	80.8
Swamp-maple (*Rufacer* spp.)	7.6
Swamp- and red-bays (*Tamala* spp.)	9.5
All others	2.1

The above table is based on only four crops—all that could be obtained, owing to the difficulty of shooting quail in the hammocks. All of these were taken in the winter. Two coveys were observed in a hammock near Gainesville during the fall and winter. Both of these left by spring. Mast is the only abundant food in the hammocks, and it is probable that quail frequent the habitat only during the period when this is shed.

TABLE V.—PERCENTAGES OF THE PRINCIPAL PLANT MATERIALS EATEN BY QUAIL SHOT OVER AGRICULTURAL LAND.

Peanuts (*Arachis hypogea*)	72.3
Chufa (*Cyperus esuculentus*) tubers	9.1
Rye (*Secale cereale*)	5.7
All others (largely weed seeds)	12.9

This table is based on fourteen crops, one taken in the summer, the others in the fall and winter.

Abandoned or fallow fields are often excellent places for quail to feed, since rag-weed, partridge-peas, Florida-beggarweed and many weeds producing quail food abound in them. Unfortunately agricultural practices make food available mainly during the fall and early winter, the time when wild food is also most abundant. If winter cover crops of vetches were more widely and generally grown, an excellent supply of nutritious food would be available during the critical spring period. Quail movements to agricultural land are influenced by the seasonal nature of farm crops, and in most areas doubtless occur most frequently in the fall and winter. In southern Florida, however, where farming is most widely practiced during the winter, weed seeds are most plentiful in the fields during the summer.

TABLE VI.—PERCENTAGES OF PLANT MATERIALS AND THE NUMBER OF CROPS IN WHICH EACH ITEM OCCURRED, FOR SOUTHERN FLORIDA IN THE SUMMER. (Based on fifteen Crops).

Plant	Percent	Occurrence
Day-flowers (*Commelina* spp.)	22.05	9
Sorghum (*Sorghum vulgare*)	17.92	1
Milk-pea (*Galactia pinetroum*)	10.17	7
Panic-grasses (*Panicum* spp.)	9.72	10
Ragweeds (*Ambrosia* spp.)	9.12	3
Caribbean-pine (*Pinus caribaea*)	5.15	2
Croton linearis	4.58	4
Poisonwood (*Metopium toxiferum*)	4.38	2
Dwarf-lantana (*Lantana depressa*)	2.99	2
Wood-sorrel (*Xanthoxalis* sp.)	2.11	1
Florida-trema (*Trema floridana*)	1.91	1
Shore-bay (*Tamala littoralis*)	1.44	2
Tragia spp.	1.39	3
Melanthera spp.	1.36	4
Piriqueta spp.	1.29	3
Physalis spp.	.89	7
Solanum spp.	.67	1
Tithymalopsis Curtisii	.63	4
Rhynchosia spp.	.62	1
Paspalum spp.	.57	2
Scleria spp.	.47	5

The balance was composed of *Acalypha* spp., *Jacquemontia* spp. *Hypoxis* spp., *Rynchospora* spp., *Trichostema* sp., *Stillingia linearifolia*, and a few undetermined seeds.

TABLE VII.—CUMULATIVE TABLE SHOWING PERCENTAGES OF THE PRINCIPAL PLANT FOODS AND THE NUMBER OF CROPS IN WHICH EACH ITEM WAS FOUND, BASED ON ALL CROPS EXAMINED, REGARDLESS OF SEASON OR HABITAT.

Plant	Percent	Occurrence
Partridge-peas (*Chamaecrista* spp.)	18.47	76
Milk-peas (*Galactia* spp.)	13.38	106
Quercus spp. (Acorns only)	11.87	40
Peanuts (*Arachis hypogea*)	7.35	14
Panic-grasses (*Panicum spp.*)	4.32	106
Gopher-apple (*Geobalanus oblongifolius*)	4.18	9
Wax-myrtles (*Cerothamnus* spp.)	3.24	13
Ragweeds (*Ambrosia* spp.)	2.73	23
Rynchosias (*Rhynchosia* spp.)	2.57	51
Sweet-gum (*Liquidambar Styraciflua*)	2.31	8
Pines (*Pinus* spp.)	1.95	23
Bays (*Tamala* spp.)	1.35	7
Summer-farewell (*Kuhnistera pinnata*)	1.34	26
Blueberry (*Cyanococcus Myrsinites*)	1.30	10
Day-flowers (*Commelina* spp.)	1.26	18
Quercus spp. (Oak galls)	1.27	15
Sorghum (*Sorghum vulgare*)	1.01	1
Dwarf-beggarweed (*Sagotia triflora*)	.98	15
Chufa (*Cyperus esculentus*) tubers	.93	3
Finger-grasses (*Syntherisma* spp.)	.90	22
Prairie-clovers (*Petalostemon* spp.)	.85	4
Nut-rushes (*Scleria* spp.)	.81	34
Paspalums (*Paspalum* spp.)	.64	58
Spurge-nettle (*Bivonea stimulosa*)	.60	3
Beggarweeds (*Meibomia* spp.)	.59	48
Crotons (*Croton* spp.)	.51	26
Aneilema (*Aneilema nudiflora*)	.38	4
Bush-clovers (*Lespedeza* spp.)	.36	16
Violets (*Viola* spp.)	.28	21
Lupines (*Lupinus* spp.)	.26	4
Dwarf-sumac (*Rhus Copallinum*)	.26	6
Butterfly-pea (*Bradburya virginiana*)	.26	14
Poison-wood (*Metopium toxiferum*)	.26	2
Sand-peas (*Cracca* spp.)	.26	2
Native crotalarias (*Crotalaria* spp.)	.26	17
Dog-tongue (*Eriogonum tomentosum*)	.25	14
Gallberry (*Ilex glabra*)	.24	6
Anychiastrum Baldwinii	.22	1
Blue-curls (*Trichostema* sp.)	.21	8
Star-grasses (*Hypoxis* spp.)	.20	40
Dwarf-lantana (*Lantana depressa*)	.17	2
Magnolias (*Magnolia* spp.)	.17	1
Wood-sorrels (*Xanthoxalis* spp.)	.12	10
Tragias (*Tragia* spp.)	.12	7
Yellow-foxtail (*Chaetochloa lutescens*)	.12	22

TABLE VII.—Continued

Plant	Percent		Occurrence
Wheat (*Triticum aestivum*)	less than .12	—	1
Buttonweed (*Diodella teres*)	"	—	4
Couple-caps (*Acalypha* spp.)	"	—	10
Ground-cherries (*Physalis* spp.)	"	—	9
Beak-rushes (*Rynchospora* spp.)	"	—	7
Galingales (*Cyperus* spp.)	"	—	5
Sun-roses (*Crocanthemum* spp.)	"	—	2
Melanthera spp.	"	—	4
Nightshades (*Solanum* spp.)	"	—	2
Rushfoil (*Crotonopsis* sp.)	"	—	2
Wire-grass (*Aristida stricta*)	"	—	1
Wild-cherry (*Padus virginiana*)	"	—	1
Hackberry (*Celtis* sp.)	"	—	2
Inkberry (*Phytolacca* sp.)	"	—	3
Huckleberry (*Decachaena tomentosa*)	"	—	5
Gopherberry (*Lasiococcus dumosus*)	"	—	2
Tithymalopsis Curtisii	"	—	4
Wild-grape (*Muscadinia* sp.)	"	—	1
Mexican-clover (*Richardia* spp.)	"	—	3
Florida trema (*Trema floridana*)	"	—	1
Piriqueta spp.	"	—	8
Sensitive-briar (*Leptoglottis* sp.)	"	—	1
Poison-ivy (*Toxicodendron* spp.)	"	—	1
Hellfetter etc. (*Smilax* spp.)	"	—	1
Smartweed (*Persicaria* sp.)	"	—	1
Wild-geranium (*Geranium carolinianum*)	"	—	1
Hog-peanut (*Falcata comosa*)	"	—	1
Queen's-delight (*Stillingia* spp.)	"	—	13
Virginia creeper (*Parthenocissus*)	"	—	1
Swamp-maple (*Rufacer* sp.)	"	—	1
Mistletoe (*Phoradendron* sp.)	"	—	1
Spermolepis divaricata	"	—	1
Natal-grass (*Tricholaena rosea*)	"	—	2
Milkweed (*Asclepias* sp.)	"	—	1
Secula viscidula	"	—	4
Jacquemontia sp.	"	—	1
Blackberries (*Rubus* spp.)	"	—	1
Alicia (*Chapmannia floridana*)	"	—	1
Pencil-flower (*Stylosanthes* sp.)	"	—	1
Rubiaceous seeds (undetermined)	"	—	7
Leguminous seeds (undetermined)	"	—	8
Cucurbitaceous seeds (undetermined)	"	—	1
Euphorbiaceous seeds (undetermined)	"	—	2
All other undetermined seeds	"	—	8

Discussion of Table VII: In many instances, where only generic mention is given, much of the material was actually identified to species. In such genera as *Galactia, Chamaecrista, Panicum, Cerothamnus* and *Scleria* this is especially true.

From this table it may be determined that small seeds are not commonly eaten except when whole capsules of them can be taken at once. It is rather surprising that over 50% of the plant food was included in only four genera; *Chamaecrista, Galactia, Quercus* and *Arachis*. None of the acorns were swallowed intact and none of their hard seed coats were eaten. At least 95% of the acorns were of the turkey-oak (*Quercus laevis*). The fact that over 1% of oak galls[8] was eaten was unexpected. These are certainly not a nourishing item in the quail diet. The absence of seeds from either of such common plants as coffeeweed (*Emelista Tora*)[9] and bladder-pod (*Glottidium vesicarium*) supports existing opinion that these plants are toxic.

TABLE VIII.—SHOWING PERCENTAGES OF THE MORE IMPORTANT ORDERS OF INSECTS EATEN, BASED ON ALL CROPS EXAMINED.

Orthoptera (nymphs and adults)	43.0
Hymenoptera (larvae and adults)*	31.0
Coleoptera (larvae and adults)	9.7
Lepidoptera (chiefly larvae)	5.2
Hemiptera (nymphs and adults)	4.5
Homoptera (nymphs and adults)	2.6

*At least ninety percent were larvae of a pine saw-fly (*Neodiprion lecontei* Fitch).

TABLE IX.—A LIST OF THE ANIMAL MATTER FOUND IN ALL CROPS (Determined by T. H. Hubbell, except the Mollusca and Coleoptera which were identified by F. N. Young).

MOLLUSCA
Class GASTROPODA—Snails
Polygyra sp.
Planorbis sp.
ARTHROPODA
Class CHILOPODA—Centipedes
Family Scolopendridae
Class DIPLOPODA—Myriapods
Family Polydesmidae
Class ARACHNIDA—Spiders, etc.
Order ARANEAE—Spiders
Family Argiopidae—Orb-weavers
Argiope sp.
Family Lycosidae—Wolf-spiders
Family Attidae—Jumping Spiders
Class INSECTA—Insects[10]
Order ORTHOPTERA
Family Phasmatidae (= Phasmidae auct.)—Walking-sticks
Anisomorpha buprestoides (Stoll) (adult female with eggs)
Manomera tenuescens (Scudder)
Family Tetrigidae (= Acrydiidae auct.)—Grouse-locusts
Neotettix femoratus (Scudder)
Neotettix bolteri Hancock
Paratettix rugosus (Scudder)
Family Acrididae—Grasshoppers, Locusts
Subfamily Acridinae—Slant-

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[8] It seems likely that quail mistake these small, spherical galls for seeds of *Tragia* spp. which they greatly resemble.

[9] Stoddard (1936) found a few of these seeds in some crops which he examined, but not enough to cause ill effect. I found three of these seeds in one gizzard.

[10] It is notable that most of the insects eaten are of medium to large size.

faced Grasshoppers
Mermiria picta (F. Walker)
Orphulella pelidna (Burmeister)
Dichromorpha viridis (Scudder)
Macneillia obscura (Scudder)
Amblytropidia occidentalis (Saussure)
Subfamily Oedipodinae—Colored-winged Locusts
Chortophaga australior Rehn and Hebard
Scirtetica marmorata picta Scudder
Pardalophora phoenicoptera (Burmeister)
Subfamily Cyrtacanthacridinae —Spine-breasted Locusts
Schistocerca americana americana (Drury)
Schistocerca damnifica calidior Rehn and Hebard
Schistocerca juv., cf *obscura* Scudder
Gymnoscirtetes pusillus Scudder
Melanoplus rotundipennis (Scudder)
Melanoplus puer seminole Hubbell
Melanoplus femur-rubrum propinquus Scudder
Melanoplus keeleri keeleri (Thomas)
Paroxya atlantica atlantica Scudder (probably)
Aptenopedes aptera borealis Hebard
Aptenopedes sphenarioides apalachee Hebard
Family Gryllacrididae—Cricket-locusts, Cave-crickets
Ceuthophilus latibuli Scudder
Family Tettigoniidae—Katydids, etc.
Amblycorypha uhleri Scudder
Scudderia sp.
Neoconocephalus sp. juv.
Belocephalus subapterus subapterus Scudder
Odontoxiphidium apterum Morse
Orchelimum sp. juv.
Family Gryllidae—Crickets
Gryllulus assimilis (Fabricius)
Miogryllus verticalis (Serville)
Anaxipha sp.
Order NEUROPTERA
Family Chrysopidae, larvae
Order HEMIPTERA
Family Thyreocoridae—Negro-bugs
Thyrecocoris sp.
Family Cydnidae — Burrowing-bugs
Pangaeus bilineatus (Say)
Family Scutelleridae—Shield-bugs
Chelisoma guttatum (Herrich-Schaeffer)
Family Pentatomidae—Stink-bugs
Brochymena sp.
Euschistus servus (Say)
Euschistus ictericus (Linnaeus)
Mormidea lugens (Fabricius)
Thyanta calceata (Say)
Thyanta castra Stal
Family Coreidae-Squash-bugs
Chariesterus antennator (Fabricius)
Acanthocephala confraterna (Uhler)
Leptoglossus phyllopus (Linnaeus)
Family Coriscidae—Broad-headed Bugs
Leptocorisa tipuloides (DeGeer)
Coriscus pilosulus (Herrich-Schaeffer)

- Family Lygaeidae—Chinch-bugs
  - *Geocoris uliginosus* (Say)
  - *Orthaea longulus* (Dallas)
  - *Orthaea bilobata* (Say)
  - *Heraeus plebejus* Stal
  - *Lygaeus facetus* Say
- Family Reduviidae—Assassin Bugs
  - *Repita taurus* Fabricius
  - *Zelus cervicalis* Stal
  - *Pselliopus cinctus* (Fabricius)
- Family Nabidae—Damsel Bugs
  - *Nabis capsiformis* Germar
- Family Miridae—Leaf-bugs
  - *Lygus* sp.

Order Homoptera
- Family Fulgoridae—Lantern-flies
  - *Phylloscelis atra atra* (Germar)
  - *Phylloscelis atra albovenosa* Melichar
  - *Hysteropterum punctiferum* (Walker)
  - *Myndus slossoni* Ball
- Family Cicadidae—Cicadas (nymph)
- Family Membracidae—Tree-hoppers
- Family Cercopidae—Frog-hoppers
  - *Monecphora bicincta* (Say)
- Family Cicadellidae—Leaf-hoppers
  - *Oncometopia lateralis* (Fabricius)
  - *Oncometopia* sp.
  - *Draeculacephala 7-guttata* (Walker)
  - *Cicadella bifida* Say
  - *Gypona* sp. cf. *citrina* Spangberg
  - *Jassus* sp.
  - *Spangbergiella* sp.
- Family Coccidae—Scale-insects
  - *Ceroplastes* sp.—wax-scale

Order Lepidoptera—Moths, Butterflies
- Family Tineidae—Tineid Moths (larvae)
- Family Notodontidae — Prominents, Puss Moths
  - *Datana* sp., larvae
- Family Sphingidae—Sphinx Moths (1 large larva)
- Family Geometridae — Geometers (larvae), 1 teneral moth
- Family Nymphalidae—Four-footed Butterflies
  - *Basilarchia* sp., probably *floridensis* (Strecker), 1 larva

Order Coleoptera—Beetles
- Family Carabidae—Ground-beetles
- Family Cicindelidae—Tiger Beetles (larvae)
- Family Histeridae—Hister Beetles
  - *Gnathoncus* sp.
- Family Cantharidae—Soldier Beetles
  - *Chauliognathus* sp., larva
- Family Elateridae—Click-beetles
  - *Melanotus* sp.
- Family Buprestidae—Buprestid Beetles
  - *Chrysobothris* sp.
- Family Scarabeidae—Scarab Beetles (larvae)
- Family Chrysomelidae—Leaf-beetles
  - *Oedionychus* spp.
  - *Disonycha* sp.
  - *Tymnes* sp.
  - *Cryptocephalus* sp.
  - Also pupae
- Family Curculionidae—Snout-beetles
  - *Pachneus opalus* and many other spp.

Order Hymenoptera—Ants, Bees, Wasps and Allies
- Family Tenthredinidae—Saw-flies
  - *Neodiprion lecontei* (Fitch) —Pine Sawfly. Many larvae and some adults
  - *Atomacera ruficollis* Norton (?), adults

Family Cynipidae—Gall-wasps (1 adult)
Family Formicidae—Ants
    Odontomachus haematodes (Linnaeus)
    Camponotus caryae Fitch (?)
    Camponotus castaneus (Latreille) (?)
    Camponotus socius Roger
    Camponotus spp.
Family Nyssonidae (?) (1 small wasp)
Order Diptera—Flies
Family Stratiomyidae—Soldier Flies
    Hermatria sp., numerous teneral specimens, half males and half females, probably taken as males mated with emerging females.
Family Solvidae (Xylomyiidae) —(larvae)
Family Tabanidae—Horseflies (1 teneral adult)
Family Sarcophagidae—Flesh-flies
    Larvae from parasitized Walking-stick, *Manomera*
Family Tachinidae—Tachinid Flies (1 puparium)

VERTEBRATA

Class AMPHIBIA
Order Salientia—Frogs and Toads
    Hyla femoralis Latreille—Tree-frog, 1 individual

Quail Weights and Food Supply

The average weight of twenty-four mature male birds taken in central Florida and from the vicinity of Gainesville was 161.4 grams, the range being from 134 to 173 grams. The average weight of twenty-one mature females from the same regions was 165.7 grams, the range being from 140 to 198 grams. The heaviest bird was gravid. The average weight of thirteen mature male birds shot in Dade County was 152.3 grams, with a range from 135 to 170 grams. A gravid female from this region, hit by an automobile shortly before being found, weighed 187 grams.

The greater average weight of the males in the group from central Florida and the Gainesville area is to be expected since the larger race *Colinus v. virginianus* occurs in the northern part of the peninsula. All of the birds from Dade County are, of course, of the smaller race *floridanus*. None of the birds taken were in notably poor condition. From a study of their weights it seems that in the regions studied the food factor is not a critical one for quail—at least not in areas where much hunting is done and not at seasons other than early spring[11]. It should be remembered, however, that by the time birds reach poor condition they are very apt to fall victim to predators, and therefore would not often be shot by a hunter.

Summary

1. Mature quail in peninsular Florida were found to eat about 86% plant matter and 14% animal matter.

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[11] Too few birds were taken at this time of year to permit the drawing of accurate conclusions as to food sufficiency in early spring.

2. Seasonal variations were as follows: spring—78.6% plant matter, 21.4% animal matter; summer—76.8% plant matter, 23.2% animal matter; fall—93.3% plant matter, 6.7% animal matter; winter—99% plant matter, 1% animal matter.

3. Four genera (*Chamaecrista, Galactia, Quercus,* and *Arachis*) together included over 50% of the plant material eaten.

4. Only seventeen genera (including the above) comprised as much as 1% or more of the total plant material.

5. Animal matter was made up largely of insects of the orders Orthoptera (mostly grasshoppers) and Hymenoptera (mostly sawfly larvae); together these orders composed about 75% of all animal matter.

6. Field studies, both of quail and of their food, showed that flatwoods are more frequented in the spring, while sandhills are preferred in the fall. Hammocks are usually frequented only in the fall and winter. The use of agricultural land by quail is determined largely by the seasonal nature of agriculture, tending to be greatest in the fall and winter. Spring is the critical period for quail, as far as food is concerned.

7. While none of the birds shot was in notably poor condition, this does not necessarily mean that food is not a limiting factor, since few birds were taken in the critical spring period, and since the chance of obtaining birds in poor condition by hunting is slight, such birds being very apt to have fallen victim to predators.

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THE FRESH-WATER JELLYFISH IN FLORIDA

C. Francis Byers

Department of Biology, University of Florida

On August 15, 1943, Mr. R. H. Schultz collected some two dozen specimens of the fresh-water jellyfish, *Craspedacusta sowerbii* Lankester[1], in Little Lake Elbert at Winter Haven, Polk County, Florida. They were brought to Dr. Horton H. Hobbs of the Department of Biology, University of Florida, and were kept alive in his laboratory until September 11, 1943. This is the first known record of the occurrence of this jellyfish in Florida.

These Florida specimens are, on the average, rather small for the species. They average only 7 to 10 mm. in diameter, as compared with the 12 mm. usually given as the diameter of mature specimens. The height of the bell is about one-half the diameter. The number of tentacles in these specimens varies with the size (and probably the age) of the individual[2]. The tentacles are arranged in at least three sets of different lengths; the smallest and most numerous hang free from the edge of the bell, while those of the two larger sets are fused for a short distance to the inner side of the bell. The velum is well developed, thick, and gelatinous. Four radial canals and one ring canal are present. The manubrium is long and rather large, with four large, non-crenated lips. The four gonads hang as elongated sac-like pouches from the radial canals.

In only a few of the Florida specimens are the gonads well developed, and even in these all four gonads are not equally mature. The margin of the bell and the gonads are pale green in color; this was especially evident in the living specimens as observed in the laboratory. As far as can be discovered the Florida material consists entirely of males. This was determined by making slides and comparing Florida specimens with females collected by Dr. J. S. Rogers in Barton Pond, near Ann Arbor, Michigan. Some of the Little Lake Elbert individuals were imperfect and apparently injured[3].

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[1] Synonyms: *Craspedacusta ryderi* (Potts); *Microhydra ryderi* Potts; *Limnocodium victoria* Allman.

[2] Payne (1924) counted 181 tentacles on a 5 mm. specimen and 348 on a 12 mm. specimen.

[3] Payne (1924) suggests that this apparently not uncommon condition in fresh-water jellyfish may be in part the result of attack by parasitic amoebae.

Little Lake Elbert is a small, roughly circular, natural lake about 400 yards in diameter. It joins Big Lake Elbert by way of a narrow connection. Jellyfish were not found in the larger lake, and Mr. Schultz states that they have not been noticed in any of the many other lakes of the vicinity, with one exception.

The lake has moderately clear water, a mud bottom, and a narrow (maximum width 18 feet), irregular and interrupted shore zone of emergent vegetation with a few waterlilies scattered here and there. Bass and gar-pike are common in it, as are also turtles and clams. The jellyfish were collected some 80 feet from shore and about 100 yards from the end of Central Avenue, Winter Haven. At the place of collection the depth of the lake is about 15 feet, and here the medusae occurred fairly plentifully in small schools 2 to 4 feet beneath the surface. Mr. Schultz captured them by shallow diving and the use of a small tea-strainer. He noted that the schools seemed to be deeper in the water on cloudy days and nearer the surface on clear days.

Specimens were first observed in this lake about August 1, 1943; the material collected was obtained on August 15th; and jellyfish had disappeared by September 15th, at a time when the water of the lake was more turbid than usual. According to Mr. Schultz jellyfish had been noticed in Little Lake Elbert the year before (1942), and were reported as having been seen in another clear-water lake in the vicinity of Winter Haven.

Mr. Schultz informed us that on reaching Gainesville with the living jellyfish he transferred one lot of them to city tap-water, and that these immediately died. The remainder were kept in pond water, and remained alive until September 11th, when they were preserved. The living jellyfish were fascinating creatures to watch, and quite graceful in movement. The behavior and swimming habits of the medusa have been described by Miss Milne (1938) and Dr. Payne (1924), and need not be discussed here.

Life History, Ecology and Distribution

Although the data presented above constitute the principal contribution of this paper, *Craspedacusta sowerbii* is sufficiently interesting and little enough known to the average biologist to warrant a review of what has been discovered as to its life history, ecology, and geographic distribution.

Life History. The occurrence of only one sex in any given locality at a particular time is a peculiarity of the species that has been commented upon, often at some length, in most accounts of this coelenterate. Males and females have been found at the same time and place only rarely. One notable exception was the discovery in 1926 of both sexes in fairly equal numbers at four places in the Kentucky River near Lexington, Kentucky, by W. R. Allen, Fernandus Payne, and Leonard Giovannoli (Payne, 1926).

In 1924 and 1926 Dr. Payne published accounts of the life history of this jellyfish, based upon material from the Kentucky River. He found that the fertilized eggs produced by the medusa give rise to a ciliated blastula from which, through polar ingression, a solid gastrula develops. The gastrula loses its cilia and elongates to form a planula-like larva with two layers of cells and a large central cavity, and this larva in turn develops into the hydroid (polyp) stage[4].

The hydroid stage of the freshwater jellyfish was first collected in this country by Edward Potts in 1885, near Philadelphia, Pennsylvania and was named by him *Microhydra ryderi,* a synonym of *Craspedacusta sowerbii.* The polyp is a small, hollow, cylindrical animal without tentacles, varying in length from a fraction of a millimeter in very young individuals to about 2 mm. in the larger ones. The polyps may occur singly or in small colonies, and are attached to some object, remaining fixed in position though exhibiting slow bending movements. They will swallow almost anything with which they come in contact if it is small enough to be taken into the mouth. The latter is a small circular opening at the distal end of the polyp, surrounded by nematocysts. There is no structure comparable to the protective perisarc of *Obelia,* but the animal is enclosed in a loose case of vegetable detritus held together by a secreted substance. The oral end of the polyp projects from this case and is never retracted.

The hydroid may reproduce in any of three ways, according to Payne (1924): (1) by *ordinary budding,* much as in *Hydra,* except that the buds remain attached, forming small colonies; (2) by producing *planula-like buds,* which become detached to form individual polyps, this being probably the chief method of reproduction; (3) by forming *medusa-buds,* from which mature medusae (jellyfish) develop.

Appearance of the medusa stage of *Craspedacusta sowerbii* is a definitely seasonal phenomenon. Most of the published records of its occurrence are for August and September (Mr. Schultz's observations in Little Lake Elbert thus conforming closely to previous information); it has been reported less often in July, and still less frequently in October.

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[4] When Mr. Schultz was informed of the desirability of finding the larval or hydroid stage, he made a careful search for it in Little Lake Elbert. He found some Hydra-like animals, but they proved not to be the hydroid of *C. sowerbii,* but probably some species of the genus *Hydra.*

Ecology. Thirty-two records of the finding of this jellyfish over a period extending from 1897 to 1938, (Bennitt, 1930; Schmitt, 1939) describe the habitat sufficiently to give some idea of its nature. From an analysis of these I have tabulated the occurrence of *Craspedacusta sowerbii* as follows:

A. OCCURRENCE IN NATURAL HABITATS

1. *Rivers* (4 records). Kentucky River, Kentucky; Willamette River, Oregon; Huron River, Michigan; Potomac River, Virginia. In the two latter, collections were made in pond- or lake-like bodies of water connected with the river.
2. *Lakes* (3 records). Cranberry Lake, New Jersey; Sandy Lake, Pennsylvania; Blue Lake, Arkansas.
3. *Ponds* (3 records). Black Pond (Lake Erie), Pennsylvania, etc.

B. OCCURRENCE IN SMALL SEMI-NATURAL HABITATS

4. *Small Bodies of Water,* variously noted as Pot Holes, Quarry Pools, Gravel Pits, Limestone Quarries (7 records).

C. OCCURRENCE IN ARTIFICIAL HABITATS

5. *Artificial Lakes* (3 records). Boss Lake near Elkhart, Indiana; Crystal Lake, Virginia; Gatun Lake, Canal Zone.
6. *Indoor Aquariums* (3 records). New York, New York; University of Washington, Seattle, Washington; Porto Alegre, Brazil.
7. *City Water Supply Systems* (2 records). Washington, D. C.; Birmingham, Alabama.
8. *Small Artificial Bodies of Water,* noted variously as Rock Pools, Concrete Pools, Garden Pools, Lily-Pools, Goldfish Ponds, Artificial Ponds, Private Fish Pools, etc. (8 records).

From this table it may be seen that *Craspedacusta sowerbii* has been encountered much more frequently in artificial bodies of water (22 records) than in natural ones (10 records). Its occurrence in Little Lake Elbert, a natural body of water, is therefore of note. Perhaps the fact that artificial bodies of water are more numerous and more closely observed, especially in the vicinity of cities, may account for the apparent preference of the jellyfish for this type of situation; or on the other hand there may be some actual biological reason for the phenomenon.

The sporadic appearance of the medusa is also characteristic, judging from the published accounts. W. T. Davis found medusae in Brady's Pond on Staten Island, New York, each year from 1933 to 1937 inclusive. Schmitt (1938, p. 86) comments that this is "a very consistent record, in view of the otherwise apparently sporadic and irregular occurrence." Again, Dr. Payne found both medusae and hydroids in Boss Lake, Indiana, over a period of several years (Payne, 1924). But these and a few others like them are exceptions to the generally recorded observation, "appeared one year only."

Geographic Distribution. The Florida record makes this state the twenty-first from which *C. sowerbii* has been collected, not counting the District of Columbia nor the indoor aquarium record from the state of Washington[5].

As might be expected, the great preponderance of records is from the humid eastern and southeastern portions of the United States, the only reported occurrences west of the 100th meridian being one from the Willamette Valley in Oregon and the aquarium record from Seattle, Washington. None of the records lies north of the parallel of 45°N., and the western limital records are in Iowa, eastern Kansas, east-central Oklahoma, and south-central Texas. There is a gap in the distribution by states in this eastern area, which includes North and South Carolina, Tennessee, Mississippi and Louisiana; but this hiatus is more likely the result of inadequate collecting than a real discontinuity in range.

Outside of North America *Craspedacusta sowerbii* has been found to have a highly discontinuous but almost world-wide range. It is known from the Panama Canal Zone, Brazil and Chile; from the Hawaiian Islands; from Japan and China; and from at least eight European countries—Russia, Poland, Czechoslovakia, Germany, Austria, France, Holland, and England. Such a distribution—wide but discontinuous—is characteristic of primitive organisms of very ancient origin (the Onychophora, for example). Although *Craspedacusta* is not reported from Africa, the closely related genus *Limnocnida* occurs in the fresh-water lakes of the African plateau[6] and in tributaries of the Niger River. A species of *Limnocnida* is also reported from an Indian stream.

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[5] The states: Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Texas, Virginia, West Virginia.

The medusae of *C. sowerbii* were first discovered in London in 1880 by Mr. Sowerby, in one of the botanical tanks in Regent's Park. This tank had been stocked with Brazilian water-lilies. According to Hyman (1940, p. 461) "later findings in other European botanical ponds containing the same water-lily support the supposition that the animal was brought from Brazil with the plant."

Miss Hyman (1940) classifies *Craspedacusta* as a member of the order Trachylina of the Hydrozoan Coelenterates. It is placed in the family Petasidae, which also contains the well-known marine jellyfish *Gonionemus.* The fresh-water coelenterates *Hydra, Craspedacusta,* and *Limnocnida* are marked exceptions to the otherwise strictly marine character of the members of this phylum.

The foregoing account of the habits and distribution of our freshwater jellyfish presents an interesting picture and suggests some curious problems, which may be summarized as follows:

1. It would seem that these jellyfish usually occur in small artificial or semi-natural bodies of water in or very near cities. Are we to be content with with the mere statement that "they are more apt to be found in such situations?"

2. They appear in the fall of the year in the United States (in March in Chile). Why? Is this an effect of declining water temperatures, or are other factors involved?

3. Only one sex is usually found in any one specified environment. Again why? Dr. Payne (1924, 1926) suggests two possible reasons: (1) Perhaps the hydroids are of only one sex in any particular environment. (2) Environmental factors may influence the production or favorable development of one sex or the other. Dr. Payne favors the latter explanation.

4. The medusae appear sporadically. The most common experience is to find them one year only in a particular habitat. It is my suggestion that this may be tied up with the peculiarities of the life cycle, especially with the production of the planula-buds by the hydroid. It is feasible to argue that this method of reproduction has been so successful that, except under rare and

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[6] It is interesting that in *Limnocnida tanganicae* Günther only males have been found in Lake Tanganyika and only females in Lake Victoria Nyanza—a situation parallel to that in *Craspedacusta.*

unknown conditions, it supplants the formation of medusa-buds. This would mean that medusae would appear only rarely, and that the hydroid, which is very small and inconspicuous, could live undetected for a long period of time in any suitable habitat. Payne (1926) found hydroids but no medusae in Boss Lake in 1924 (he had found medusae there for some years previous). He also found hydroids but no medusae at Benson Creek, Kentucky in 1925. He believes that the hydroids are much hardier than the medusae.

5. *Craspedacusta sowerbii* has a sporadic and apparently haphazard geographic distribution. This presents a very interesting problem to the zoogeographer. How is the species disseminated? Almost certainly through the hydroid stage. Perhaps the hydroid attaches to and is transported on aquatic vegetation (the Amazonian water-lilies, for example); or perhaps fish are responsible (the jellyfish is very common in garden and ornamental pools stocked with fish); perhaps wading birds carry it from place to place; it may be associated with clams; or perhaps all of these or none are involved. What was the method and the center of its origin? Payne (1926) states," The fact that both males and females occur in the Kentucky River may indicate that this is their point of origin from marine life. During the elevation of this region, which at times has been part of the sea, it is possible that *Craspedacusta* became cut off from the main sea and that it was able to adjust itself to the slow change from salt to freshwater."

Perhaps this is the explanation of the origin of this jellyfish, and perhaps it is not. In any case, it introduces a final speculation—that concerning the position of the freshwater jellyfish in the series of Hydrozoan Coelenterates. The older idea, that *Hydra* is the most primitive of the Coelenterates, is gradually giving way to the belief that forms such as *Obelia* occupy this position, and that *Hydra* is a derived form. To me, the life-history of *Craspedacusta* greatly strengthens this surmize. It gives the appearance of a Hydrozoan attempting to eliminate the alternation of generations by reduction of the medusa stage—an undertaking successfully accomplished by *Hydra* but only with partial success by *Craspedacusta.*

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THE OCCURRENCE OF FOWLER'S TOAD, *BUFO WOODHOUSII FOWLERI* HINCKLEY, IN FLORIDA

M. Graham Netting and Coleman J. Goin

Carnegie Museum, Pittsburgh, Pa., and *University of Florida*

Herpetological references are beautifully indefinite about the southern limits of the range of *Bufo woodhousii fowleri.* Stejneger and Barbour (1943: 44) state, for example, "southward to Georgia. . . . Not known in peninsular Florida," inferring that the form is known in northern or western Florida. Since Carr (1940) did not list *fowleri* as occurring in Florida, Mr. Wilfred T. Neill, Jr., wrote to him about a Florida record for the form. Dr. Carr was kind enough to refer this matter to us, and Mr. Neill provided additional details (letter, July 1, 1941): "In 1938, while spending a few days at White Springs, on the Suwanee River, I observed several *Bufo woodhousii fowleri.* This interested me because I had failed to find that form in southern Georgia. I examined several specimens, all typical *fowleri,* but unfortunately preserved only one." Mr. Neill, with his customary generosity, later donated this toad, and a number of other Florida specimens of his collecting, to the Carnegie Museum. Subsequently the junior author collected a number of specimens of *fowleri* at three different localities in western Florida.

The above-mentioned specimens have been examined critically and compared with specimens of *fowleri* from the Gulf Coast of Mississippi and from the Piedmont of Alabama and Georgia. We find that specimens of *B. woodhousii fowleri* can be distinguished from *B. terrestris* at almost any size. Specimens of *terrestris* show distinct crests (under magnification) at a snout-to-vent length of 20 mm, whereas those of *fowleri* do not, and by the time a 30-mm snout-to-vent length has been reached, individuals of *terrestris* begin to exhibit characteristic heightening and flaring of the posterior ends of the longitudinal crests. At the same size, the longitudinal crests of *fowleri* are just becoming distinct, and, although they may diverge posteriorly, they are not noticeably raised and they are usually connected by a plateau. The knoblike development of the posterior ends of the longitudinal crests, and the separation between the transverse crests and the paratoids, permit easy recognition of *terrestris,* provided the specimens are 35 mm in snout-to-vent length, or larger. No attempt should be made to distinguish *fowleri* and *terrestris* on the basis of number of warts to a dorsal spot, for *terrestris* often resembles *fowleri,* and differs from *americanus*, in having three or more warts to a dorsal spot.

We have examined the following specimens of *B. w. fowleri* from Florida:

Hamilton County
White Springs on the Suwanee River—1 adult male (CM 21637)
Santa Rosa County
5 mi. NW of Chumuckla, Waters Lake—1 juvenile (CM 21418)
8 mi. SW of Jay, McCaskill Mill Creek—2 adult males (CM 21399-400)
3 juveniles (CM 21401,21485,21488)
Washington County
Ebro, Choctawhatchee River—1 juvenile (CM 21374)

With the exception of the White Springs example, these specimens agree, as well as might be expected in view of their varying sizes, in coloration and structure. All are less contrastingly marked than northern specimens of *fowleri.* The two males in the series (CM 21399-400) are of breeding age, for they have vocal pouches and nuptial excrescences, yet their snout-to-vent measurements are but 44.5 and 46.6 mm respectively, 12 mm or more shorter than the average for mature males from various northern localities (Netting, 1930: 438). The specimen secured by Mr. Neill at White Springs (CM 21637) agrees more closely with our southernmost Georgia specimens (CM 13078-80, from ten miles south of Gray, Jones County) than it does with the western Florida specimens, for its cranial crests are better developed and its markings are somewhat brighter.

Cope began the concluding paragraph of his treatment of *Bufo lentiginosus americanus*, in "The Batrachia of North America" (1889: 288), with this sentence: "A well-marked variety of this subspecies, or *perhaps* [italics ours] a distinct subspecies, is represented by two specimens from Micanopy, Fla., which were obtained by Dr. Bean." In writing the sequent description of these specimens, Cope apparently convinced himself of their distinctness, for he concludes with the statement: "This form may be called *Bufo lentiginosus pachycephalus.*" Burt (1938: 338) summarily disposed of this name by stating, "The two U.S.N.M. cotypes of *B. lentiginosus pachycephalus* have been examined and they are typical *fowleri.*" The last of many favors we received from the late Dr. Stejneger concerned these toads. In answer to a query he wrote, "I find among my notes the following: 'The locality of 14681 Micanopy, Fla. Dr. T. H. Bean is not beyond suspicion, on the contrary. The entry is in Rheem's handwriting, with time of receipt and accession no. queried. There is nothing to indicate the authority for locality and collector.'" Last year a visit to Washington provided the senior author with the long awaited opportunity to examine these cotypes. His conclusions are as follows:

1) The cotypes of *Bufo lentiginosus pachycephalus* Cope are not referable to *fowleri* as stated by Burt. They agree with *fowleri* in having unspotted venters, but in no other respect. Differences in wart distribution, cranial crests, pattern, and form are well marked.

2) The cotypes do not belong to any form of *Bufo* known to occur in eastern North America.

3) The cotypes resemble specimens of *compactilis* in some respects, but differ in having more oval paratoids and in having the femur free of the body skin.

4) At present, *Bufo lentiginosus pachycephalus* Cope cannot be placed, with certainty, in the synonymy of any North American *Bufo*.

Bufo woodhousii fowleri occurs on the Atlantic Coastal Plain south to North Carolina, at least; in South Carolina and Georgia it is common on the Piedmont and in the mountains, reaching the amazing altitude of 4250 feet on Tray Mountain in northeast Georgia, as reported by Harper (1935: 283); in Alabama the species is rather generally distributed, ranging from the mountainous northeastern corner of the state to the Gulf Coastal Plain in Mobile County. The western Florida records for Santa Rosa and Washington counties are, therefore, a not unexpected eastern extension of the range of the form on the Gulf Coastal Plain. The Hamilton County locality, however, is completely isolated and eludes explanation on any logical distributional basis. It is unlikely that any confusion in data has occurred in this instance, for Mr. Neill was astonished at finding the form at White Springs, as indicated by the quotation from his letter. We suspect that the White Springs record may represent a recent establishment of the form, following an accidental or deliberate introduction. If this toad had long been resident on the upper Suwanee River, it appears inconceivable that it would not have extended its range along this stream into the Okefinokee Swamp. Information bearing on this point, or small collections of toads obtained along the Suwanee River at various localities, will be welcomed by the authors.

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THE MOVEMENTS OF THE FLORIDA EAST COAST BROWN PELICANS

R. J. LONGSTREET
Florida Audubon Society

The eastern brown pelican, characteristic water bird of the Florida Atlantic and Gulf coasts, breeds on the Atlantic shores chiefly at one spot—Brevard Reserve in Mosquito Lagoon, near Titusville. Prior to 1922, the colony had been located for many years in the Indian River near Sebastian, where many famous ornithologists studied the home-life of this grotesque bird.

The winter range is given by Bent[1] as follows: "From the Bahamas, Florida, and the Gulf coast of the United States southward, including all the West Indies and the eastern coasts of Central and South America, as far south as Brazil." Bent further states that the brown pelicans "are not strictly migratory, as they are generally resident in the near vicinity of their breeding grounds, but after the cares of the nesting season are over, they become more or less nomadic, and some few of them, generally young birds, often wander long distances."

It is the object of this paper to report what has been discovered concerning the movements of the brown pelican in the last quarter of a century by the use of bird-banding, a device wholly unused in the study of pelicans (and very little in any field of ornithology) when Bent's work was published. Our data are limited to work with the Brevard rookery, which, however, produces most of the pelicans found along the Atlantic coast.

Bird-banding became a part of the work of the United States Biological Survey in 1920. Since that time, the Bureau (now the Division of Fish and Wild Life) has furnished serially numbered metal bands to qualified observers (called co-operators) in all parts of the country, and all reports are made to the government agency. Many problems of bird life are solvable only by banding. In particular, banding enables us to ascertain the movements of individual birds. Thus when Bent wrote that the winter range of the eastern brown pelican extends into all of the West Indies, there were no data to prove whether the birds seen there and in Central and South America came from the Atlantic coast or from the Gulf coast or perhaps from some other breeding area.

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[1] Bent, A. C. Life Histories of North American Petrels and Pelicans and their Allies. *U. S. National Museum, Bull.* 121, 1922.

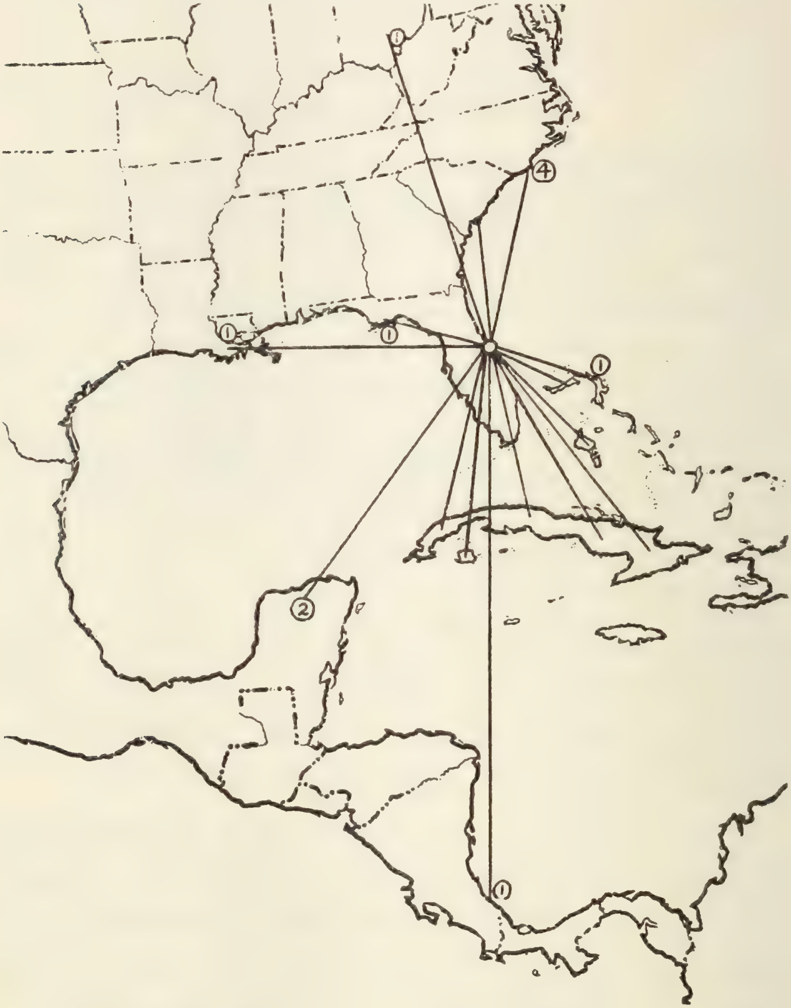

Fig. 1.—Map showing the movement of the Florida East Coast brown pelicans, with number reported from the most distant points.

In 1925, a committee[2] of members of the Florida Audubon Society began a study of the movements of the eastern brown pelicans nesting at Brevard Reserve. So far as the records published by the government indicate, the first brown pelicans to be banded in the United States were 50 juvenals (the only age operable, of course) on Feb. 28, 1925. A report covering the period 1925-1935 was published in the *Florida Naturalist* for July, 1936. At that time, 143 "returns" had been received from a total of 1973 pelicans banded. (The "returns" are based on bands found on wounded, disabled, sick, dead or captured birds wherever retrieved.) The present report includes these data and covers all operations from 1925 to 1942. The following table summarizes the results of this work.

LOCALITIES WHERE BIRDS WERE RECOVERED

Operators 1925 to 1942	Florida	Cuba	S. C. & Ga.	Bahamas	Nicaragua	Yucatan	Ohio	Miss
Howell (1933-34)	2	3		1				
Kimball (1940)		10						
Westfall (1938-40)	12	9						
Davis & Davis (1934-37)	80	37				2		
Mason (1937-39)	71	38	9		1		1	1
Longstreet (1925-41)	86	32	3	4				
Total Returns	251	129	12	5	1	2	1	1

The accompanying map indicates the directions of travel, but is on too small a scale to show numbers of returns in each locality. Figures have been inserted only for most distant ranges. Greater detail is given in the following analysis.

Analysis of Movements

1. Very few (14) of the birds have moved north of Florida (to Georgia and South Carolina).
2. A third of the birds (32% plus) have gone to Cuba, many to the southern shores.
3. The Bahamas, where pelicans are reported in winter and which seems a logical place for our birds to wander to, has furnished only five returns out of 402.

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[2] E. M. and W. M. Davis, C. R. Mason, and the author. A few bands were placed by Audubon Society members E. Kimball, M. J. Westfall and J. C. Howell.

4. There are five remarkable 'stragglers'—two to Yucatan, one to Nicaragua, and one each to Ohio and Mississippi. Bent had previously reported the following 'casual records': three to Nova Scotia, one each to Missouri, Wyoming, and Colorado.
5. None of our east coast pelicans has been found in any part of the West Indies or South America.
6. Very few (12) have been found on the Gulf coast of Florida, and only 7 on the Florida Keys, indicating that there is almost no tendency to mix with the Gulf coast birds. Note that the populous Tampa-St. Petersburg area has produced no returns whatever.
7. There are a few (7) returns from "inland" Florida.
8. Twenty-seven pelicans have been returned from the Florida east coast north of Brevard Reserve, compared with 160 from the east coast south to Miami.

Bent stated that most of the wanderers are young birds. Birdbanding makes it possible to verify this because the bands are affixed while the birds are in their juvenal plumage, before they can fly, and therefore when they are only a few weeks old. The dates of the returns provide the check. Thus, of 129 returns from Cuba and 64 from the Miami area, less than 8% were of birds that had been as much as one year on the wing. But the returns from the area 100 miles north and south of the rookery provide 15% which have been more than one year from the time of birdbanding. Almost twice as many adults have been recovered from nearer the ancestral home as have been found farther to the south. (The birds returned from north of Florida were all juvenals excepting the Mississippi individual which was a little over two years old. Of the Cuban returns, numbering 129, only 29 were of birds more than a year old.)

In this connection, it may be observed that our 402 returns have revealed very few "old" pelicans, indicating a high mortality rate. In the first period (1925-1935), of 1973 banded birds, only five were found two years after the banding date. In the period 1936 to 1942, we have 258 returns, of which ten were of birds from the 1925-35 period. One of these was banded Oct. 20, 1934, and was returned April 15, 1941, at an age of about six and one-half years. Another, banded Sept. 20, 1933, was returned in October, 1939. Both of these "oldsters" were returned from within 50 miles of Brevard Reserve.

SUMMARY

The banding of eastern brown pelicans at the Brevard Reserve, Florida, has:

1. Substantiated Bent's statement that these birds are generally resident in the near vicinity of their breeding grounds, but that after their nesting season they become more or less nomadic, and some few of them, generally young birds, often wander long distances. But, more specifically, we can add (a) that the east coast birds do not wander to the north of Florida, choosing rather the lower Florida east coast and Cuba (b) that this movement, mostly by birds of the year, is much more general than the words "some few" would indicate, and (c) that "long distances" (for these birds at any rate) means not farther than the southern shores of Cuba.

2. Showed that the "winter range" of the Florida east coast brown pelicans does not include the Bahamas or the West Indies; the brown pelicans seen there, and on the Gulf coast in winter, are not our Atlantic coast birds.

ADDENDA TO THE LIST OF BIRDS OF ALACHUA COUNTY, FLORIDA. II.

J. C. DICKINSON, JR.
University of Florida

These addenda bring the known list of birds of Alachua County, Florida[1] to 213 species and subspecies. Although some sight records are here recorded, I am in complete agreement with the majority of ornithologists in questioning the validity of most such records, and have therefore listed only those made under circumstances which preclude any possibility of error.

ADDITIONAL NOTES

32. BLUE-WINGED TEAL.—*Querquedula discors* (Linnaeus) A. O. U. 140. Migration dates for this species are now available. On October 28, 1939, I recorded a flock of twelve birds on Lake Alice. Blue-winged Teal continued to frequent this lake until March 30, 1940. In 1941 small flocks were seen on Bivin's Arm on September 10.

60. FLORIDA CRANE.—*Grus canadensis pratensis* Meyer A. O. U. 206a. This is an exceedingly rare species in Alachua County. I saw three individuals over Leadworth Prairie, near Micanopy, on November 9, 1940. The group flew directly over me and was observed with 8x binoculars.

NEW RECORDS

208. LESSER SCAUP DUCK.—*Nyroca affinis* (Eyton) A. O. U. 149. I believe that this species has been omitted from previous lists only through oversight. It is a common winter resident. A group frequented Lake Alice during the winter of 1939-1940, arriving on September 30 and departing on April 17. It is a fairly common bird on most of the lakes of Alachua County. I took nine specimens (four females and five males) on Leadworth Prairie on November 9, 1940.

209. EASTERN SPARROW HAWK.—*Falco sparverius sparverius* Linnaeus A. O. U. 360. As McClanahan[1] suspected, this species does occur in Alachua County. A specimen collected by Frank N. Young and Albert M. Laessle, on December 7, 1939, proved to be a male of this species. It measured: L. 11.0; W. 7.6; T. 4.75; B. from N. 0.46.

210. COMMON TERN.—*Sterna hirundo hirundo* Linnaeus. A. O. U. 70. I saw three individuals on Bivin's Arm, September 18, 1941. The birds were feeding over the lake, and were watched for an hour with a 20x spotting telescope. All were in winter plumage.

211. BLACK TERN.—*Chlidonias nigra surinamensis* (Gmelin) A. O. U. 77. About fifty of these birds were observed on Bivin's Arm on September 14, 1941. They remained there in smaller numbers for about a week. All of the birds that I saw were in winter or changing plumage.

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[1] McClanahan, R. C., "Annotated List of the Birds of Alachua County, Florida," *Proc. Florida Acad. Sci.*, vol. 1 (1936), pp. 91-102; Dickinson, J. C., Jr., "Addenda to the List of Birds of Alachua County, Florida," *ibid*, Vol. 4 (1939), pp. 106-107.

212. PECTORAL SANDPIPER.—*Pisobia melanota* (Vielliot) A. O. U. 239. Jack C. Russell collected a specimen near Prairie Creek on the eastern end of Payne's Prairie, September 26, 1940. It was brought to me for examination; although definitely identifiable, it was in such poor condition that it was not saved.

213. NORTHERN WATER-THRUSH.—*Seirus noveboracensis noveboracensis* (Gmelin) A. O. U. 675. I have examined two male specimens of the Northern Water-thrush, both collected by Jack C. Russell in Alachua County. The first was taken April 11, 1940, the second September 25, 1940.

214. KENTUCKY WARBLER.—*Oporornis formosus* (Wilson) A. O. U. 677. One individual was seen by Jack C. Russell on September 19, 1940.

THE FLORIDA YELLOW BAT, *DASYPTERUS FLORIDANUS*

H. B. Sherman
Department of Biology, University of Florida

The Florida yellow bat is one of our less common species and little has been published concerning it other than distribution records. Specimens collected during the past 13 years make possible some additions to our knowledge of the biology of this species. Since all of the available information regarding this bat is not voluminous, it seems desirable to bring these data together and point out their implications.

Dasypterus floridanus was named in 1902 by Miller, who pointed out that it is similar to two other members of this genus, *D. intermedius* of Texas and Mexico and the smaller *D. xanthinus* of Lower California, between which it is intermediate in size. Other species of *Dasypterus* have ranges extending through Central and South America as far south as Argentina.

Tabulation of the distribution records of *D. floridanus* shows that they consist of three localities in central and southern Louisiana, one in southern Mississippi, one near Charleston, S. C., and thirteen in Florida. The absence of records from the southern parts of Alabama and Georgia probably results from lack of intensive collecting in these regions. This contention is supported by the fact that one of my specimens of this species was shot by H. K. Wallace over the St. Marys River where this stream forms the boundary between Georgia and Florida on U. S. Highway No. 1. The bat dropped into the water near the Florida shore, where it was retrieved by R. E. Bellamy, and thus missed being a record for Georgia by only a fraction of a mile.

In addition to the collectors just named, I have to thank J. S. Rogers, Jr., George Van Hyning, E. Ross Allen, Oscar E. Baynard, F. N. Young and J. C. Dickinson Jr. for aid in securing other specimens of this species. For information concerning specimens in other collections I am indebted to the authorities of the Museum of Zoology of Louisiana State University, U. S. National Museum, U. S. Fish and Wildlife Service, Museum of Comparative Zoology, Academy of Natural Sciences of Philadelphia, Cornell University, American Museum of Natural History, British Museum (Natural History), Museum of Zoology of the University of Michigan, and the Florida State Museum.

Of the 70-odd specimens to be found in various collections, 29 were taken in the vicinity of Gainesville, Florida. This series of 29 individuals furnishes some interesting data concerning the abundance of the two sexes in this region, and the reproductive cycle of the male.

The Gainesville specimens consist of 7 females, 21 males, and one the sex of which is unknown. Only one specimen, a female, is definitely immature, but it was probably large enough to fly at the time of its capture. This young individual and an adult female, probably its mother, were found by C. E. Nelson in a large pine tree which was felled on the campus of the University of Florida, July 6. It is remarkable that females have not been taken in this area earlier in the year than July. The five other females were taken on the following dates: July 24 and 28, August 29, September 5 and 23. On the other hand, males probably occur in this region throughout the year, for they have been taken in all months except January, May and November.

In contrast to these conditions in the Gainesville region, at Baton Rouge, Louisiana, George Lowery took 10 specimens in March, April and June, all of which are females with the exception of one male taken March 14.

These distribution records indicate that sexual segregation occurs in spring and early summer, at which time the females are pregnant or the young are small. This implies a more or less extensive seasonal migration of one or both sexes.

Records of small young for this species are available from three localities. At Seven Oaks, Pinellas Co., Florida, A. H. Howell secured a yellow bat on June 7, 1918, which he states was nursing young. At Baton Rouge, Louisiana, Lowery found a female with three young clinging to her on June 17, 1932. The third record is from Ocala, Florida. Through the kindness of E. Ross Allen, I received a mother and three young of this species which were collected in the city on June 20, 1941.

Since the localities where young have been found are rather widely separated, it seems probable that the migrations which result in sexual segregation are of rather limited extent. This may also explain the fact that a male and two females are recorded from Houma, Louisiana in May. Information is not available concerning the habitats from which these three specimens were taken.

These records seem to indicate that the young of this species are born in late May or early June. It also seems probable that a maximum number of four young will be found for this species. This was predicted by Lyon in 1903, on the basis that four mammae are present in the yellow bat, as in other closely related genera in

The number of fully grown specimens of each sex taken in each month at different localities is given in table 1. In this table "?" indicates sex is unknown.

TABLE 1—SEASONAL DISTRIBUTION OF RECORDS OF THE FLORIDA YELLOW BAT

Locality	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Date Unknown	Total		
														♂	♀	?
SOUTH CAROLINA																
Charleston	......	......	......	......	......	......	1♀	......	......	......	......	......	....	......	1	......
MISSISSIPPI																
Hancock County	......	......	......	......	1?	......	......	......	......	......	......	......	....	......	......	1
LOUISIANA																
Baton Rouge	......	......	1♂	......	......	......	......	......	......	......	......	......	....	1	......	......
	......	......	2♀	5♀	......	2♀	......	......	......	......	......	......	....	......	9	......
Houma	......	......	......	......	1♂	......	......	......	......	......	......	......	1?	1	......	1
	......	......	......	......	2♀	......	......	......	......	......	......	......	....	......	2	......
Lafayette	......	......	......	......	2♀	......	......	......	......	......	......	......	....	......	2	......
FLORIDA																
Bunnell	......	......	......	1♂	......	......	......	......	......	......	......	......	....	1	......	......
Chassohowitzka R.	......	1♂	......	......	......	......	......	......	......	......	......	......	....	1	......	......
Davenport	......	......	1?	......	......	......	......	......	......	......	......	......	....	......	......	1
Gainesville	1?	1♂	1♂	1♂	......	3♂	1♂	8♂	5♂	1♂	......	1♂	....	22	......	1
	......	......	......	......	......	......	3♀	1♀	2♀	......	......	......	....	......	6	......
Hillsborough R. State Park	......	......	......	......	......	......	......	1♂	......	......	......	......	....	1	......	......
Lake Geneva	......	2♂	......	......	......	......	......	......	......	......	......	......	....	2	......	......
	......	1♂	......	......	......	......	......	......	......	......	......	......	....	......	1	......
Lake Kissimmee	......	......	3♂	......	......	......	......	......	......	......	......	......	....	......	3	......
Lakeland	......	......	......	......	......	1♂	......	......	......	......	......	......	....	1	......	......
Ocala	......	......	......	......	......	1♀	......	1♀	......	......	......	......	....	......	2	......
Old Town	......	......	......	......	......	......	3♂	......	......	......	......	......	....	3	......	......
	......	......	......	......	......	......	1♀	......	......	......	......	......	....	......	1	......
Mullet Lake	......	......	......	......	......	......	......	......	......	......	1?	......	1?	......	......	2
St. Marys River	......	......	......	1♂	......	......	......	......	......	......	......	......	....	1	......	......
Seven Oaks	......	......	......	......	1♂	1♀	......	......	......	......	......	......	....	1	1	......
TOTALS: Males	......	4	2	3	2	4	4	9	5	1	......	1	....	35	......	......
Females	......	1	5	5	4	4	5	2	2	......	......	......	....	......	28	......
Sex ?	1	......	1	......	1	......	......	......	......	......	1	......	2	......	......	6

which litters of three or four young are common. In most species of bats the usual number of young per litter is one or two.

The reproductive cycle of the male yellow bat is fairly well outlined by the condition of the testis and epididymus of nine specimens taken near Gainesville, Florida. These organs were studied by means of sections and the presence or absence of spermatozoa, together with collection date for each specimen, is recorded below.

COLLECTION DATE	SPERMATOZOA IN:	
	TESTIS	EPIDIDYMUS
February 11	None	Many
June 13	"	None
August 1	"	"
August 13	"	"
August 17	Few	Few
August 23	"	"
September 1	Many	Many
October 2	"	"
December 8	"	"

The observations tabulated above show that the males are sexually immature from June through the first half of August, but become mature by the first of September and remain in that condition until at least the 11th of February. This is the typical male reproductive cycle for vespertilionid bats, the group to which the yellow bat belongs. Judging from what is known of other species, it seems probable that ovulation occurs in late winter or early spring in this species, following which time the males presumably again become sexually immature.

The available data concerning the habitat preferences of the yellow bat indicate that this species chooses the drier situations. The occurrence of individuals in a pine tree on the University of Florida campus has already been mentioned, and I have two other specimens which were picked off of shrubbery on the same campus. Other individuals have been shot in hammocks and over old fields. I have no records of the occurrence of this bat in low pine flatwoods or in caves.

Flying insects apparently compose the food supply of this mammal. In the stomach of one individual (Sherman, 1939) were found remains of Homoptera, Zygoptera, a fly of the family Anthomyiidae, beetles of the families Dytiscidae and Scolytidae, and winged ants.

Although no information is available concerning the enemies of the Florida yellow bat, the barn owl is known to feed on a closely related species, *Dasypterus intermedius*. In fact, the only record of the latter species for Cuba (Beaufort, 1934) consists of a skull found in an owl pellet. The fact that these bats sometimes, if not regularly, roost in the open, suggests that birds of prey may be their chief enemies.

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RECENT LITERATURE AND SOME NEW DISTRIBUTION RECORDS CONCERNING FLORIDA MAMMALS

H. B. SHERMAN

University of Florida

Since the preparation of the list of Florida mammals[1], which was published in 1937 in the first volume of the Proceedings of this Academy, a number of new species have been described, the names of others have been changed, and other important information concerning the mammals of the state has become available. It is the purpose of this paper to summarize these data in order to bring the list up to date. The literature involved will be considered in order of date of publication.

1936. HALL, E. RAYMOND. Mustelid mammals from the Pleistocene of North America with systematic notes on some recent members of the genera *Mustela*, *Taxidea* and *Mephitis*. *Carnegie Inst. Washington*, Publ. no. 473. p. 69, *Mephitis mephitis elongata* (Bangs) for *Mephitis elongata* (Bangs). p. 105, *Mustela frenata peninsulae* (Rhoads) for *Mustela peninsulae peninsulae* (Rhoads). *Mustela frenata olivacea* Howell for *Mustela peninsulae olivacea* Howell.

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1939. HOWELL, A. H. Descriptions of five new mammals from Florida. *Jour. Mammalogy*, vol. 20, no. 3, pp. 363-365. The new forms are:

Scalopus aquaticus bassi. Type locality: Englewood, Sarasota Co., Florida.

Peromyscus polionotus decoloratus. Type locality: Near Mosquito Inlet, Volusia Co., Florida. Range: Known only from type locality and from Bulow; probably occurs from Mosquito Inlet north to Matanzas Inlet.

Peromyscus polionotus peninsularis. Type locality: St. Andrews Point Peninsula, Bay Co., Florida. Range: Known only from type locality and from Cape San Blas, Florida.

Peromyscus gossypinus restrictus. Type locality: "Oak Lodge," on the peninsula opposite Micco, Brevard Co., Florida.

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In addition to the data on Florida mammals contained in the publications cited above, the following records deserve mention, since they increase the known ranges of the species concerned. All of the specimens except that of *Eptesicus* are in the author's collection.

Eptesicus fuscus osceola. A specimen of this bat was taken by Stewart Springer in one of the buildings of the Bass Biological Laboratory at Englewood, Charlotte Co., Florida. The species is also recorded by Rand and Host (1942, see above) from Southern Highlands County. Hitherto it has been known only from the vicinity of Tarpon Springs, Florida.

Corynorhinus macrotis. The second Florida record of this bat is based on a specimen taken by Leonard Giovannoli in a building of the Florida Caverns State Park near Marianna, Florida. The previous record, published by H. Allen in 1893, is that of a specimen taken at Micanopy, Alachua County, Florida.

Neotoma floridana floridana. A specimen taken at Murdock, Charlotte Co., Florida, by Jimmy Hughes, was sent me by Stewart Springer. This is the southernmost record for *Neotoma* in the state.

Neofiber alleni. A specimen taken at Carrabelle, Franklin Co., Florida was received from Dr. Ezda M. Deviney of Florida State College for Women. This record extends the known western limit of distribution of this species by more than one hundred miles.

Finally the status of the deer of south Florida deserve mention. Davis (1943, p. 238) states that approximately 4,000 deer were killed in Hendry and Collier Counties in 1940 and 1941 to aid in the control of the fever-tick which infests cattle. However, enough deer remain to restock themselves and . . . "the deer should become more plentiful in a few years, especially since other deer will be brought in to replenish and improve the stock." Hamilton (1943, pp. 399-401) indicates that *O. v. seminolus*, described by Goldman and Kellogg in 1940, is confined to the southern Everglades, *O. v. osceola* occurs only in the southern tip of peninsular Florida, and *O. v. virginianus* is found in the northern part of the state and as far south as Palm Beach on the east coast. From these statements it appears that *O. v. seminolus* is the race whose numbers were reduced to eradicate the cattle-fever tick. State Veterinarian J. V. Knapp informs me that " . . . 35-37% of the deer killed in Collier County during the first phase of the deer reduction program were found upon inspection to be carrying cattle-fever ticks; however, as the deer were reduced in numbers the percentage of infestation likewise fell and eventually ceased altogether." Dr. I. N. Kennedy, Director of the Game and Fresh Water Fish Commission, informed me (letter, June 9, 1944) that no restocking of deer has been done as yet in the Big Cypress of Collier County. It is to be hoped, that when and if restocking takes place, all parties concerned will cooperate in preserving these unique races of the fauna of our state.

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BIOLOGICAL BACKGROUND OF SOCIAL SCIENCES

RAYMOND F. BELLAMY

Florida State College for Women

It is my desire in this paper to champion the line of thought which holds that a biological background is at least of great value, if not indeed a *sine qua non,* for any considerable degree of understanding of social or even individual behavior. It will be seen that for the purposes of this paper, psychology will be included among the social sciences.

There has always been some argument against the theory here defended, and at present this negative attitude seems to be growing in favor. Alexander A. Chamberlain once snorted that one might as well study cats for the purpose of understanding camels as to study animals for human psychology. If this statement is to be considered as a challenge, it may be readily accepted. The obvious answer is that it is quite sensible to study cats to learn about camels. Cats are much cheaper than camels, they are smaller, and they are easier to obtain and to handle, especially on the dissecting table, and what is more important at present, they are not so good to eat.

There are many thousands of things about circulation, assimilation, respiration, reproduction, and other processes, as well as about bone construction, nerve stimulation and transmission, muscle functioning, etc., which are common to cats and camels. Moreover, there are many phases of behavior, many elements of fear, anger and sex, which certainly seem to be similar in cats and in camels. Without attempting to be scientifically accurate, I would estimate that a student of camels should study about ten thousand cats and finish up with some eight or ten camels.

Just as it is cheaper, easier, and better to substitute cats for camels, so it is preferable to dissect, mutilate, incarcerate, stimulate, annoy, and otherwise experiment on animals rather than on human beings.

If the experimentation on animals is limited to the search for physiological or purely biological facts, there will be little or no objection. It is universally understood that our first line of attack is over the bodies of animals. This practice dates back to the very beginning of our knowledge about our own bodies. Aristotle lived in an age when such experimenting was forbidden, but his writings show rather plainly that he had surreptitiously pried into the vital organs of living creatures. From Aristotle's time on, it may be said that those alone who carried out such experiments contributed to our knowledge. This does not mean, of course, that the work of others was not important. An Emmanuel Kant might give stimulation and inspiration which would last for all ages. He might pose questions and advance suggestions which would be of immeasurable value in aiding our attempts to learn about, interpret, and understand our store of knowledge. But such things add nothing to our store of knowledge itself.

In recent decades experimentation on animals has contributed much information which is basic to our very culture. Among other things, we have learned much about the nature of disease, and the ways of vaccines, transfusions and serums. Just now from experiments with blood circulation, especially in Russian laboratories, we are learning about life itself. When our inquisitive experimenters succeeded in producing pure white rabbits from a black mother by the expedient of transplanting ovaries,[3] our knowledge of the laws of heredity was carried far ahead.

Perhaps one of the most interesting results of experiments in injections was the modern technique of blood tests, which has shown us among other things that we are rather startlingly close akin to the apes—closer to the apes than are the South American monkeys.

What might be called another whole universe of information is the vast field of the vitamins and all their ramifications. This, of course, from the observation of broken blood vessels in young chicks to our latest studies in feeding white rats, has been secured almost exclusively by experimenting on animals. The same is true of our knowledge of the various forms of dynamite stored in the ductless glands, dating back to the early days and to such experiments as the work done on pancreatic glands of dogs which resulted in our discovery of insulin.

These earlier and somewhat spectacular studies in heredity, glandular secretions, etc., gave us the foundation on which our multitudinous present day investigations are building ever more significant structures. Almost every day we are presented with new and significant facts which help us in the understanding of mankind.

From physiological and anatomical fields, it is a short step indeed to the investigation of questions which have psychic, or mental and even social implications. In this field also the contribution of the biological experiments has been great.

An important chapter was added to our store of knowledge when Jacques Loeb brought out his studies of the tropisms.[18,25] Like so many other new suggestions, these tropisms became academic best sellers and were ridden hard for a few years, and then were gradually forgotten, so that now the term is rarely heard. But even if the name itself has become extinct, the addition which Loeb gave to our knowledge of human behavior remains.

The Russian, Pavlov, made another great contribution when he connected tubes with the salivary ducts of dogs and brought out the new term—conditioned reflex.[31] It is interesting to note that Pavlov was not a psychologist at all and knew nothing about psychology. He was merely performing a biological experiment. It was not long before Krosnogorski adopted his methods and experimented on Polish children, giving them a spoonful of honey as a stimulus.[23] (We may say parenthetically that this would have been quite a heavy stimulus for our average American child.) At any rate when Mateer improved on Krosnogorski's method and worked with American children, she found it preferable to substitute a bit of chocolate as her stimulus or stimulus-reward.[29] Since then the conditioned reflex has become as intimate as part of our stock in trade as astigmatism or the dark brown taste in the mouth after painting the town red.

What little we know about memory, learning, etc. stems pretty largely from experiments with amoebae and rotifers—which we found really do possess memories and have the capacity to learn—and with such higher animals as earthworms, crayfish, rats, raccoons, and apes.[40] A difficulty was encountered when the attempt was made to experiment with gorillas, since they are stubborn and uncooperative, and refuse almost completely to play the game. This perhaps, shows their close resemblance to man and also shows why, after all, we must so often go to the lower animals for our experimentation rather than to man himself.

Up to this point the evidence is rather clear that our biological methods and our experiments on lower animals have been fruitful in enlarging our knowledge and understanding of ourselves. But from here on, we encounter skepticism and objection, and it must be acknowledged that demonstration becomes more difficult and less convincing. To summarize the argument of our worthy opponents, they would say that it is all very well to measure the amount of heat produced when a frog's muscle contracts to further our knowledge of human muscular action, but it is ridiculous to record the chirps of a cricket in the hope that it will help us understand the behavior of a love-sick adolescent youth. Perhaps we must grant that there is much truth in this, especially as there is no hope of understanding a love-sick youngster anyway. Yet it is our contention that we can profit much from a good biological background in our struggle to comprehend human competition, conflict, cooperation, adjustments, interactions in general and such phenomena as angers and fears, curiosity, submission, leadership, patriotism, religion and love, and the typical practices of war, sports, strikes, political activities, and all the other things to which human flesh is heir.

Historically, much of our approach has been biological in nature. Unfortunately during the recent past, this type of study has centered almost exclusively around a discussion of instincts. This preoccupation was so pronounced that there is still a general impression that all biological approaches to the study of human behavior consist exclusively in studying instincts. The extremes to which McDougall and his contemporaries went turned the mass of modern scholars against the whole procedure. It is no wonder that these moderns went to opposite extremes, quite as excessive as the position from which they fled. Unfortunately, they also manifested a tendency to lump the whole biological field together with the instincts, and throw it all out the window.

It is well for us to remember that we are all animals, and that all animals have much in common. Not only are our assimilation, respiration, locomotion, reproduction and all such processes subject to the same laws and in many ways practically identical with those of related animals, but fear is fear and anger is anger whether experienced by a bear, a frog, a gorilla, or a bishop. There is much deep truth in the young girl's song—

> Oh in the moonlight, when we are holding hands,
> Oh in the moonlight, I think I understands
> Why all the birdses, all the bearses,
> Never go in thirdses, always go in pairses
> Oh in the moonlight, I think I understands.

One or two examples may be given to illustrate specific values in a biological background. About 30 years ago there was a great mass of literature which had for its theme the destruction of war by substituting class loyalty for loyalty to country. It was pointed out that the laboring classes in England, Germany, America, France, etc. had much more in common with each other than with the capitalists of their own countries. Resounding and eloquent speeches were made about how stupid it would be for them to fight each other for the benefit of their economic overlords. Many thousands pledged themselves never to go to war against each other. This type of activity was not limited to the workers, but was engaged in by many preachers, scholars and reformers of all types. The logic was perfect, and these people confidently expected to see a great organized revolt should any war ever be declared.

But, as G. Stanley Hall remarked, man is not logical, he is psychological. When World War I broke upon an unsuspecting world, these leaders and logicians were astonished and dismayed by the spectacle of their hordes rushing to the support of their native lands, shouting and singing with patriotic ardor. Much of their dismay and astonishment was due to the fact that they also found themselves behaving exactly like the rank and file of their followers. There were few exceptions. Even such extreme socialistic and radical writers as Upton Sinclair immediately climbed on the band wagon, offering, of course, some convenient reason why they did so. Most surprising of all was the fact that down-trodden and ill-used minority groups in all countries rallied to the national defense. The Jews of Russia, with the fear of pogroms chilling their souls, offered ceremonial bread and water to the czar and pledged their full and unqualified support. Fugitives from Russian oppression in other lands endeavored to return and fight for Mother Russia. In this country the not-too-well treated Negroes manifested as deep a patriotism as any group that could be found. And our Indians, from whom the land had been stolen and who were just then being treated as badly as any group anywhere on earth, came forward to fight the battles of America. On the other hand, long suppressed national aspirations of such peoples as the Poles, Finns and Irish flared up with hopeful intensity.

All this was surprising to our logical planners, but if they had possessed a biological background it would not have been. Darwin, with his gift for noticing obscure but highly important facts, would have understood it. He observed that the wild horses on the Falklands had never left one end of the island, though there was no reason why they could not go freely to the other.[5] He explained it by what he called their natural attachment to a definite locality. He also noticed that the herds of cattle on these islands had remained in their own localities so closely that definite specific colors and types of cattle had become characteristic of the different places. Many other writers, both scientific and what we may call naturalistic, have observed the same type of thing. The attachment of seals and sea lions to their breeding grounds is well known, and Lucas states that this feeling is so strong that they will stubbornly return even when there are only two or three left. Birds persistently stick to one locality and migratory birds return to the same spot, frequently to the same nest. One pair of wild geese is said to have nested in the same clump of elders in Canada for more than fifty years. Salmon return faithfully to their spawning grounds, and individuals of other species of fish become recognized as residents of certain pools. Wolves, bears, and in fact a great variety of animals are known to stick closely to a limited region unless driven out by enemies or food shortage.

This attachment to what we may call a homeland is not limited to mammals, birds and fish, but is widespread in the animal kingdom—apparently well-nigh universal in all but the lowest forms. It seems to be true of a great many insects. Butterflies have communal sleeping places to which they return. Elaborate studies of the prominent role played by the hive or nest in the lives of bees and ants have been made by Lord Avebury,[2] McCook,[30] Wheeler,[37],[38],[39] Espinas,[8] and dozens of others,[13],[14] and strangely enough old Huber[20] more than a century ago seems to have seen their behavior more clearly than anybody else, nothwithstanding the fact that he was completely blind and had to depend on the eyes of his servant. In addition to these scientific studies, the rare power of understanding which is occasionally vouchsafed to the artistic individual enabled Fabre[9] and Maurice Maeterlinck[26,27] to give us more detailed descriptions of these home-loving creatures than their more scientific brothers.

We may say with confidence, then, that animals in general stick closely to definite places. Game technicians know this well. This fact was utilized in stamping out the foot and mouth disease which developed among the wild deer of the St. Stanislaus Mountain Range in California. In another example, the mule deer of the Kaibab National Forest almost became extinct because, strangely enough, the wolves in the forest were all killed out and wolves from other regions failed to move in and help preserve the well known balance of nature.

It is also apparent that this common attachment to a locality is accompanied by a strong emotional response. It is widely known to hunters that a wild animal which is being chased by dogs will ordinarily not go near its own home; but if it becomes evident that escape is impossible, it will put forth every effort to return to its home to die. Parenthetically, we may note the remarkable similarity between this and the behavior of Samuel Gompers, the long time leader of organized labor, who had a special train chartered to carry him out of Mexico so that he might die on United States soil. The effort was successful; he lived until he crossed the border and thus died in peace. And Samuel Gompers was one of that group which believed class loyalty could be substituted for place loyalty!

It was not until a relatively short time ago that we succeeded in bringing a live gorilla to America. Even yet, there are very few in the country. Many have died on the way or while waiting in ports of embarkation. The cause of their death is obscure, but it is thought to be due to homesickness. The evidence points strongly that way.

Wild animals seem to manifest the same type of emotion, and among domestic animals it is even more easily recognized. Dogs, cattle, horses, cats and even ducks have shown unmistakable affection for their homes. Many horses become homesick when away for even a day or two, and refuse to eat. When headed toward home they must be held in or they will wear themselves out in their hurry. In our Western Plains region there are many accounts of the extreme hardships through which horses have gone to return to their own localities. Some of these have become parts of local history.

If our advocates of class over territory had studied their biology they would certainly have wondered if man does not possess this same characteristic. Very probably they would have carried their studies further in the light of what they had learned, and would have observed human reactions. They would have found the same emotional reaction toward definite geographical regions among all peoples, a feeling so pronounced that African natives and others when taken from their countries have been known to commit suicide in the belief that their souls would return home. They would have found that in all of pre-Columbian South and North America the territory was definitely fixed for each tribe, and the feeling held for these blocks of territory was in all essentials that which we call patriotism today. They would have learned that no people on earth has ever been truly nomadic, and that peoples who apparently wander aimlessly always ''wander'' within definite limits and according to a fixed schedule, dependant on such things as when fruit gets ripe or fish are to be found in a given place, when pasture is ready for grazing on the mountain slopes, and the like. Here again Darwin's powers of observation enabled him to see that the so-called ''nomadic'' Fuegians were not nomadic at all. Others have discovered the same thing about natives of the Malay Peninsula, about the Eskimos and Siberians, and in fact all the so-called ''wandering'' peoples. Furthermore, if our friends had pursued their study, they would have been impressed with the prominent place given to some locality in all youth groups, such as gangs, clubs, societies, etc.[1],[12],[22],[32] We could spend some hours enumerating what our fictitious investigators would have found. When it had all been piled on top of that vast background of animal reaction toward a definite territory, it should have persuaded them that the attempt to substitute class loyalty for territorial loyalty would be doomed to failure—as they found out the hard way.

Parenthetically we may say at this point that no attempt has been made in this paper to explain or analyse this apparent attachment to a locality. In all probability it is not a primary or unitary reaction, but is the result of simpler factors. For our purpose, the fact that animals and men *do* manifest this deep affection for their home localities is the important point, regardless of *why* it is so. It must be taken into consideration regardless of the fact that we have not analyzed its causes.

Another illustration may be treated more briefly. In the closing decade of the 19th century, no candidate could be elected to any office whatever unless he promised vociferously to ''Bust the Trusts.'' This was followed by some years of propaganda to ''trade at home'' and ''put the mail order houses out of business.'' The present version of all this is to devise new forms of taxes to destroy the chain stores.

Any student with a biological background could have told all these people that their efforts were doomed to failure. They might ''Bust the Trusts,'' but after they were all ''busted,'' something else of essentially the same nature would have been found on the doorstep. Some especially inventive genius may formulate a law that will put the chain store out of business. If he does, it will be interesting to see what will take its place. Such stores *have* been defeated. The Danish Cooperative Societies put the big butter-and-eggs companies out of business in England,[4],[10],[11],[15],[17],[19] and the chain stores have never been able to exist in certain localities in Louisiana where strong inter-family ties exist.[16] It will be noted, however, that when the trusts and chain stores were destroyed, it was by something which possessed the same fundamental characteristics.

This is but an extension of the principle existing throughout the animal kingdom that the most successful weapon in the struggle for existence is not speed or strength, sharp claws and slashing teeth, protective armor of bone plates or sharp spines, but a capacity to live and work in groups. Darwin saw this clearly, and explained man's ascent by his ability to work in groups.[6] It is significant that Darwin arrived at this conclusion, not by observing man alone, but primarily by the study of his simian relatives. Sir Henry Sumner Maine,[28] McLennon, Galton, Westermarck,[36], Tylor,[35] and all that group of investigators looked to the lower animals for suggestions. Kropotkin was the most extreme of them all, and allowed his enthusiasm to overstress the role of Mutual Aid.[24] But the most exhaustive and probably most scholarly treatment along this line is the two volume work by the Australian, Sutherland.[34] It is inconceivable how anybody who had read even Sutherland's book alone could ever believe that he could really ''Bust the Trusts.'' He would certainly be ready to accept Ross's statement that we must accept ''monopoly,'' *i.e.*, group activity, as against individual effort. The only choice, says Ross, is between private and public monopoly.[33]

There is much political and economic agitation today along lines which lie in this field. We hear continuous discussion and wrangling over labor organizations, Leagues of Nations, socialized medicine, consumers' cooperatives, and ''the good old American way of individual initiative''—which Herbert Hoover called ''Rugged Individualism''—and which his contemporaries parodied by substituting an ''a'' for the ''u.''

If our agitators honestly want to understand these issues, we would recommend that they devote a few years to the study of biology.

It should be emphasized that one cannot become an authority on any field of psychology or sociology by merely studying biology and watching the antics of lower animals. Always, to be a psychologist, one must study psychology, and to understand human behavior he must study human beings. Biology alone cannot make a social scientist, but it furnishes a foundation and background. It suggests multitudinous lines for investigation and calls attention to many human traits which would otherwise be missed.

Moreover, there is an elusive but nevertheless very real value which is derived from the patient study of physical structure, systematic grouping of genus and species, adaptation to surroundings, and characteristic forms of behavior. The student of social sciences may be ever so brilliant, but he inevitably shows it if he lacks this biological training. Putting it crudely, he may have an enormous mass of information, but he doesn't know what it all means.

Just now there is a flood tide of political, economic, and social discussion which is characterized by this lack of insight. We can at least be thankful that a respectable number of social scientists are expressing amazement at the blind assumption made by so many of our countrymen that the United States will sail into the European field with dignity and grandeur and show all those people just how to live—and that they will all meekly accept. These are the same citizens who were surprised and hurt when Britain did not enthusiastically accept the matter-of-fact suggestion that she dissolve the Empire. They were also surprised at the chain of events by which the United States drifted into this war (for we were heading steadily in that direction, regardless of Pearl Harbor).

A somewhat sinister fact is that these foundationless conclusions are being presented to our public dressed out in all the habiliments of authority. The distinction between the scholar and the layman is rapidly disappearing. On the one hand, academic scholars are tempted to express opinions in fields which are foreign to their specialties. On the other, columnists, editorial writers, popular lecturers and many others have quite good educational backgrounds and they study up on some of these questions, sometimes for months, sometimes for several days and occasionally for a few minutes.

Every paper is full of editorials by such persons, and all magazines and journals carry articles by them. If their conclusions were all wrong, little harm would be done, but their danger lies in that they contain so much that is really valuable. This blinds us to the fact that they are so often fundamental misinterpretations. To illustrate, the magazine *Life* recently carried a rather scholarly article about the future economic policy of this country.[21] The author had done a great amount of studying of economic, political and historic questions, and he did a good job in integrating his findings. But it was evident that he had not studied biology. He listed Darwin as an individualist, along with Spencer and Sumner, and described the Darwinian doctrine as antagonistic to cooperative activity. This was fundamental to his line of reasoning, and was as fallacious as it was fundamental. He may, of course, have been quite correct in his final conclusions, but he certainly was all wrong on his premises. With such a foundation, it would not be the part of wisdom to accept his findings too whole-heartedly.

A somewhat similar editorial, but not so scholarly, was carried by the *Saturday Evening Post* a few months earlier.[7] This article was so highly pleasing to certain groups of industrialists that one company had reprints made, apparently by the tens of thousands. This article started with a false assumption about the life of primitive man, and succeeded in making about every possible mistake before the end was reached. To be sure, there was little direct reference to biology in it, but it was based throughout on mistaken biological interpretations.

The *Saturday Evening Post* and *Life* are standard provender for millions. It may safely be said that their contents and viewpoints reach nearly all our citizens directly or indirectly. Their writers have academic standing, and their words carry conviction and authority. Such being the case, it is serious when they build their systems on such completely mistaken biological concepts.

The examples selected are but two of dozens and hundreds. In addition to printed matter, the radio gives out an almost continuous stream of vocal argument of the same type. Sometimes it becomes amusing, as was the case in a recent forum program. Two nationally known authorities, like the two Kilkinney cats, began to quarrel and then to fight. Their words waxed bitter and sharp, but it was either tragic or else good comedy, since they had drifted into biological fields and it was evident that neither had had any biological preparation.

The general neglect of biology is but one phase of the modern trend. Everywhere we find that the prevailing style is to take short cuts and arrive at practical ends and final conclusions with a minimum of background. Engineers' aides by hundreds are being made out of young people who have had no calculus and very little of anything else. Practical electricians are being produced over-night. Technical experts of all kinds are being assembled in much the same way that Henry Kaiser builds ships.

A rather startling discovery is that these scantily prepared people often do quite as good work as those who have devoted half a life-time to prepartion. The case is like that of one who may be a super-efficient automobile driver without knowing anything whatever about an internal combustion engine. These technicians function well in their limited fields, but should the old guard of thoroughly trained mathematicians, physicists and engineers die off, leaving these ersätz scholars to shift for themselves, great would be the catastrophe.

As in the physical sciences, so in the field of social phenomena; we are training social workers, recreational directors, probation officers and a great variety of such persons with little or no background. In fact, it is often openly preached that it is a waste of time for them to study any such abstract phenomena. Even general sociology as such is striking out along the road of community surveys, compiling a bewildering mass of charts and tables, and finding expression in what we have learned to call regionalism. Now all this is vastly important, but more and more this structure is being built up without going to the trouble of laying a foundation. It may be highly satisfactory as long as a few ''old timers'' are still around, but when they are gone it is likely to be a different story. Engineer's aides without an engineer look rather ridiculous.

It should be remembered that a biologist is not necessarily an authority on social questions. In fact, if he is a thoroughly trained biologist he almost certainly will not be. He has had no time to study social phenomena. Moreover, he has probably specialized in some phase of biology which has little if any direct bearing on social and psychological questions. But there are certain aspects of the biological field, knowledge of which is essential for a psychologist or sociologist. Without this background, he is lost. He may speak with the tongues of men and of angels, and like Solomon put forth a thousand proverbs, but he will lack an insight, an appreciation, a comprehension, absolutely necessary if he is to understand, interpret and coordinate all the vast amount of information which in his field he may possess.

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Current books and journal articles on the various fields discussed in this paper are so numerous and so well known that it has not seemed advisable to try to list them or any portion of them. Thus even in the Proceedings of this Academy there have appeared at least eight or ten papers which might be cited in connection with the topics treated. The bibliography has therefore been restricted to the older or more obscure references. Because of the exigencies of the text, references have been cited by number instead of by author and year in the form usually followed in this journal.

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SURVEY OF FLORIDA NEWSPAPERS AND PERIODICALS: A PROJECT OF THE UNION CATALOG OF FLORIDIANA

CLARENCE DRAKE

Rollins College, Winter Park, Florida

When a carpenter decides to build a cabinet, he does not begin until he has in hand his blueprint, his material, and his tools. Why? Because these are the essential and fundamental objects that he must have before he can begin construction.

In the realms of social science, a similar procedure must be followed each time a new contribution is made to our general knowledge. The essential elements for construction in the sciences are facts. Some of us are possessed of an unsteady hand, and we feel compelled by our own lack of skill to refrain from working on the end product. We choose rather to assume the position of ''tool handler'' for the master builder. Ours is the task of gathering the facts and placing them at the disposal of those who can best use them in their scientific presentation of knowledge.

A. J. Hanna, Chairman of the Advisory Council of Union Catalog of Floridiana, has defined the purpose of the catalog as: ''(1) to answer the question, 'what is there on Florida?', by listing materials relating to that subject and thus providing a comprehensive index; and (2) to answer the question, 'Where can it be located?', by indicating on cards where information can be found. The geographic division involved is that territory recognized at any time as Florida. Beginning with the reports of Ponce de Leon's discovery of the peninsula in 1513, these records cover more than four centuries and are well along in the fifth. Studies of prehistoric cultures extend the period considerably prior to 1513.''[1]

Among the sources most frequently used by the social scientists are the newspapers and periodicals. The frequency with which newspapers and periodicals are published makes it possible for the investigator to get a vital and moving account of events. This is highly desirable to the social scientist, for such an account makes it possible for him to interpret motives and underlying causes, trace influences and movements, and analyze results. The sociologist, the psychologist, and the historian are all concerned with motivation in the story of human drama, for streams of action are directly dependent upon the motivating currents in personalities.

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[1] Hanna, A. J., "The Union Catalog of Floridiana." Reprinted from: *Special Libraries*, (New York), 32: 160-162, 179 (May-June, 1941).

Newspapers and periodicals are not only valuable because they reflect public opinion, but the variety of subjects which they include provides a wide range of interest. Alongside the authenticated news items, almost every publication has its unsophisticated columns of local chatter and gossip. Politicians have long used the printed page to flaunt their policies, while editors have long used their columns to make their cries for justice and social reform. Newspapers and periodicals currently contain everything from the homey advertisement of the latest insect spray to the erudite account of the most recent trends in science.

Since we are convinced of the importance of newspapers and periodicals, we consider it essential to include such Florida publications, both current and discontinued, in the Union Catalog of Floridiana. We believe that James Owen Knauss, formerly professor of European History at the Florida State College for Women, shares our belief in the importance of Florida publications, for in 1926 he published his ''Territorial Florida Journalism,'' a monograph locating the newspapers of Florida that were published between July 1821 and June 1845. Dr. Knauss has devoted a great deal of the space in this work to biographical sketches of the men who were pioneers in the Florida newspaper business.

Our procedure has been to build upon the firm foundations already laid by other men where possible, and to do research work when necessary. Dr. Knauss's study of Florida journalism during the territorial period, the Ayers Newspaper Directory, and the records of the Florida Press Association have been the chief sources from which we have proceeded in the gathering of material for our catalog of publications. We have supplemented these sources with numerous other miscellaneous documents and papers. Colleges, libraries, clubs, and business and fraternal organizations all have been contacted as possible sources. Our catalog shows that there are now in circulation over two hundred weekly, semiweekly, and daily newspapers in the state of Florida. We have found that there are more than fifty different periodicals being published each month by the professional, business, and social organizations in Florida.

Since our file is a catalog, we have limited our records principally to the official name, location, date of establishment, frequency of publication, and date of discontinuation, if any, for each Florida publication. We are also recording the names of editors and publishers with their dates where we have been able to gather such information. Such a record includes the names of C. E. Bartlett, W. H. Hunt, B. D. Wright, Joshua Knowles, and Joseph Clisby—men who not only distinguished themselves in the newspaper world but through their political and civic action did much to make Florida the great state it is today. Where it has been possible, we have included the political and religious affiliations of the publications.

Although work on this project will never be completed, the staff of the Union Catalog of Floridiana now places this file of Florida publications at the disposal of the social scientist in the hope that it may prove to be an efficient tool in the construction of many worthwhile contributions to Florida history.

THE CIRCULATION AND RESPIRATORY TOLERANCE OF SOME FLORIDA FRESH-WATER FISHES[1]

J. S. Hart

University of Toronto, Ontario, Canada

The morphology and physiology of living things are intimately related to the environments in which they live. The structural adaptation of animals to the conditions under which they live is frequently striking, and hence the study of morphological variation in relation to environment has been intensively pursued. The enormous differences in the vertebrate skeleton as adapted to aquatic, terrestrial and aerial habits illustrates the extent to which structural modification can proceed in relation to the requirements of different types of environment.

Physiological variations, being less apparent and often obscure, have not been so thoroughly studied. The most apparent physiological differences result from morphological differences between organisms which are not closely related. Such differences are qualitative. In closely related groups of similar structure, however, differences of behavior often occur which are attributed to physiological differences of a quantitative rather than of a qualitative nature. In reviewing the investigations dealing with physiological variations among fishes Redfield (1933) stressed their quantitative aspect.

Studies of quantitative physiological differences among Teleost fishes have dealt chiefly with respiration:

(1) Krogh and Leitch (1919) showed differences in the chemical affinity of the blood for oxygen; Willmer (1934) and Black (1940) demonstrated this more completely.

(2) Krogh and Leitch (1919) first discovered specific differences in the effect of carbon dioxide on the combining of oxygen with fish blood; such differences were more strikingly demonstrated by Root (1931), Willmer (1934), and Black (1940).

(3) Hall (1929) showed specific differences in the amount of hemoglobin per unit volume of blood, and Redfield (1933) reviewed the differences in oxygen capacity and red cell volume.

(4) Differences in the buffering capacity of the blood among marine and fresh-water species were shown by Redfield (1933).

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[1] Contribution from the Department of Zoology, University of Toronto, and the Department of Biology, University of Florida.

(5) The tolerance of fishes to varying concentrations of carbon dioxide was studied by Powers (1922, 1932), Pruthi (1927), Fry and Black (1938), and Irving, Black, and Safford (1939) for fresh-water species; and by Safford (1940) for marine species. The fishes were placed in bottles with oxygen at atmospheric pressure and carbon dioxide at tensions varying from zero to over 300 mm of mercury. The effect of these varying amounts of carbon dioxide on the lethal oxygen level was evaluated by measuring the oxygen remaining in the water after asphyxiation. The ability of a species to remove oxygen in the presence of carbon dioxide was called its *respiratory tolerance* (Irving *et al.*, 1939). This was found to vary greatly in different species.

(6) The literature dealing with the blood pressure of fishes indicates that there are large specific differences; pressures range from 13 mm in the skate (MacKay, 1931) to 100 mm in the Chinook salmon (Greene, 1904).

(7) The stroke output of the heart of the bowfin, catfish, carp, and sucker has been found to differ greatly, indicating further differences in the circulation (Hart, MS).

The present paper deals with a more detailed examination of some of these physiological phenomena, namely the respiratory tolerance, the stroke output of the heart, and the effect of beat rate and blood pressure on stroke output, all of which reveal graded differences between species. The possible significance of these quantitative differences in relation to the biology of the fishes studied is discussed.

Acknowledgements. The investigation upon which this paper is based was carried out at the University of Florida Conservation Reserve, Welaka, Florida, where most of the necessary equipment was supplied by the Department of Biology of the University of Florida. Dr. O. Lloyd Meehean, Assistant Aquatic Biologist of the U. S. Fish and Wildlife Service, was most generous in providing the use of a laboratory building on the shore of the St. Johns River at Welaka, and in making available the facilities of the Fisheries Experimental Station of which he is in charge.

During the school year Prof. J. Speed Rogers, head of the Department of Biology of the University of Florida, was on exchange with Prof. W. J. K. Harkness of the University of Toronto, and Prof. T. H. Hubbell was acting head of the department. I wish to acknowledge my indebtedness to Professors Harkness and Hubbell for their direction and assistance. Thanks are also gratefully expressed to Dr. F. E. J. Fry of the University of Toronto, who gave valuable advice during the investigation and in the preparation of this paper.

MATERIALS AND METHODS

The fishes used in this study were obtained alive from fishermen at Welaka, Florida. They were taken in the St. Johns River from October, 1940, to June, 1941, and represented the following species:

Dorosoma cepedianum (LeSueur)—Northern gizzard shad
Erimyzon sucetta sucetta (Lacépède)—Eastern lake chub-sucker
Notemigonus crysoleucas bosci (Valenciennes)—Florida golden shiner
Ictalurus lacustris punctatus (Rafinesque)—Southern channel catfish
Ictalurus catus (Linnaeus)—White catfish
Ameiurus nebulosus marmoratus (Holbrook)—Marbled brown bullhead catfish
Anguilla bostoniensis (LeSueur)—American eel
Pomoxis nigro-maculatus (LeSueur)—Black crappie
Lepomis macrochirus purpurescens (Cope)—Eastern bluegill
Huro salmoides (Lacépède)—Large-mouth bass

The tests made on these species were as follows. Tolerance to carbon dioxide was determined by placing individuals in bottles with ample oxygen and varying amounts of carbon dioxide, according to the methods of the authors cited under (5) on p. 222. The oxygen and carbon dioxide contents of the water were determined before and after the fish was asphyxiated. Oxygen content was determined by the permanganate modification of the Winkler method, using 100 cc samples (*Standard Methods for the Examination of Water and Sewage*, 1936); carbon dioxide content by titration with N/44 and N/22 sodium hydroxide with phenolphthalein indicator. The gas concentrations were converted to tensions by tables given in the *Handbook of Chemistry and Physics* (1935), and the titration figures were checked by Krogh's method (Krogh, 1908) for gas micro-analysis. Water samples of known carbon dioxide concentration were analyzed by the Krogh apparatus and the corresponding tensions obtained were such as to justify use of the conversion tables in the *Handbook*.

The stroke output was recorded with the fish out of water, ventral side up, on a fish board. Two methods were used. The first consisted in ligating the ventricle around the atrio-ventricular passage and around the passage from the ventricle to the bulbus arteriosus. The ligature threads were placed flush with the ventricle after the heart was exposed and ligated simultaneously either when the heart was fully distended or when fully contracted. The ventricle with occluded blood was then removed and weighed on a chemical balance. When the ventricle weights were plotted against the body weights of the fish, the stroke output could be determined in those species where there was a large enough difference between diastolic and systolic weights to overcome the variation between individual readings (where stroke output weights were 40-70% of the diastolic weights). Certain species, the gizzard shad and golden shiner, (where stroke output weights were 10-20% of the diastolic weights) did not lend themselves to this procedure, but in the rest the method was a good approximation and showed the stroke output under the experimental conditions.

The second method measured directly the volume of blood pumped at each beat, and was also used to determine the output at different pressures. This was done by means of an air manometer with a 10 ml bulb welded to a 1 ml pipette. The instrument was drawn out into a sharp glass tip for insertion into the bulbus arteriosus. It was graduated in 0.10 ml and in cm of water pressure units. The stroke output was determined by inserting the instrument into the bulbus arteriosus, closing the exit of the latter to the ventral aorta to deflect all the blood into the manometer, and recording the amount pumped (stroke output) and pressure at each beat, together with the beat rate. At each beat of the heart the blood rose in the manometer in smaller and smaller increments. Finally, at a volume and pressure which varied considerably in different fishes, the blood stopped rising and the ventricle did not move any more blood, although it still continued to beat, usually at the same rate. There was a definite pause between each beat, and the cardiac valves usually prevented backslipping of the blood. No attempt was made to control any of the factors which might affect the beat rate or stroke output of the heart, and a large variation was found in different individuals of the same species. The beat rate for example, varied from 5 to 50 beats per minute. The tests were made in the interest of checking the ligation method, and determining how these variations in beat rate might affect the stroke output (the ligation method does not give this information).

Determinations of blood pressure were made by the use of mercury and air manometers, the latter consisting of a bulb of approximately 1 ml capacity fused to 1 mm capillary tubing. Both manometers were calibrated against a column of water and all measurements were given in cm of water pressure. The pressure was read at the average maximum (systolic) and the average minimum (diastolic) height to which the blood rose in the manometer during the period of testing, correction being made for the weight of the column of blood in the tube. Stainless steel hypodermic needles were welded to the glass capillary for insertion into the bulbus arteriosus. All pressures were recorded from the bulbus arteriosus with the fish placed ventral side up on a fish board, in all cases out of water. The fish were usually stunned before the operation. Pressures readings obtained in this way are obviously not to be regarded as representing normal pressures, but were made in an attempt to determine the effect of variations in beat rate on blood pressure in different species. The beat rate was not controlled, and varied from 5 to 50 beats per minute in different individuals of single species. All individuals which showed abnormal or disorderly beating of the heart were excluded from consideration. The technique could not be used for continuous recording of blood pressure, for the blood soon clotted in the narrow capillary tubing; hence readings for a few beats only were taken. Hardy species such as the catfish, however, could survive for several readings on different occasions. The beat rate taken was the average of two timings, one before and one after the pressure readings. The rate did not usually change during the interval.

RESPIRATORY TOLERANCE

When a fish is placed in a bottle with an oxygen partial pressure of about 150 mm of mercury, it will usually consume nearly all of the oxygen if no carbon dioxide is present. If sufficient carbon dioxide is added, however, the fish will be asphyxiated before all the oxygen is used. The ability of different species to remove oxygen in the presence of carbon dioxide (*respiratory tolerance*—Irving *et al.*, 1939) can be conveniently compared by determining the carbon dioxide tension necessary to cause the fish to leave after asphyxiation an arbitrarily fixed oxygen tension of 80 mm of mercury in the water, *i.e.*, the carbon dioxide tension at which the lethal oxygen tension is 80 mm of mercury. This value varies greatly from species to species, as is shown in Table 1 (in this table the 80 mm values are taken from the data graphed in fig. 1).

In fig. 1 the lethal level of oxygen for each fish is related to the carbon dioxide tension found after asphyxiation. These figures reveal the following information. At carbon dioxide tensions from zero to 30 mm of mercury all species were able to remove most of the oxygen initially present in the water bottles. At carbon dioxide tensions in the 30 to 60 mm of mercury range three species are unable to consume much more than half the available oxygen; the gizzard shad has the least respiratory tolerance and

TABLE 1—RESPIRATORY TOLERANCE

SPECIES	Environmental CO_2 tension at 80 mm O_2 tension, expressed as partial pressure in mm of mercury.
Gizzard shad	35
Black crappie	50
Eastern bluegill	60
Chub sucker	67
Large-mouth bass	70
Golden shiner	91
Southern channel catfish	125
White catfish	156
Bullhead catfish	156
Eel	195

reaches this test point at a carbon dioxide tension of 35 mm of mercury, followed by the black crappie at 50 and the eastern bluegill at 60 mm. At these carbon dioxide tensions the lethal oxygen levels of the catfishes and the eel are still very low. At carbon dioxide tensions in the 60 to 100 mm range the chub sucker, large-mouth bass, golden shiner, and southern channel catfish are the next to be affected, in the order named. The lethal oxygen levels of the other catfishes and the eel are not markedly raised until the carbon dioxide tension is well over 100 mm of mercury. These latter species have therefore a large respiratory tolerance.

The great variation in respiratory tolerance found among the ten species studied at Welaka is by no means peculiar to Florida fishes. The same sort of variation was demonstrated by Fry and Black (1938) among Algonquin Park fishes, by Irving, Black, and Safford (1939) among Pennsylvania species, and by Safford (1940) among marine forms. In Algonquin Park the specific variation in respiratory tolerance was noted to be correlated with differences in habitat and temperature, whenever there was some isolation of the different species. In the instance of the St. Johns River we are dealing with a homothermous environment, of almost uniform chemical characteristics throughout any given cross-section. In this quite uniform environment live fishes that differ widely in their respiratory tolerance; and it will be interesting to learn whether or how far the observed differences are correlated with differences in their habits and habitats. A correlation of respiratory tolerance and habitat is not considered inevitable. It may, however, be pointed out that the gizzard shad, with the lowest tolerance, is a species of the open water, while the much more highly tolerant catfish, bullhead and eel are bottom-dwellers, and the last even buries itself in mud for considerable periods (Hubbs and Allen, 1944).

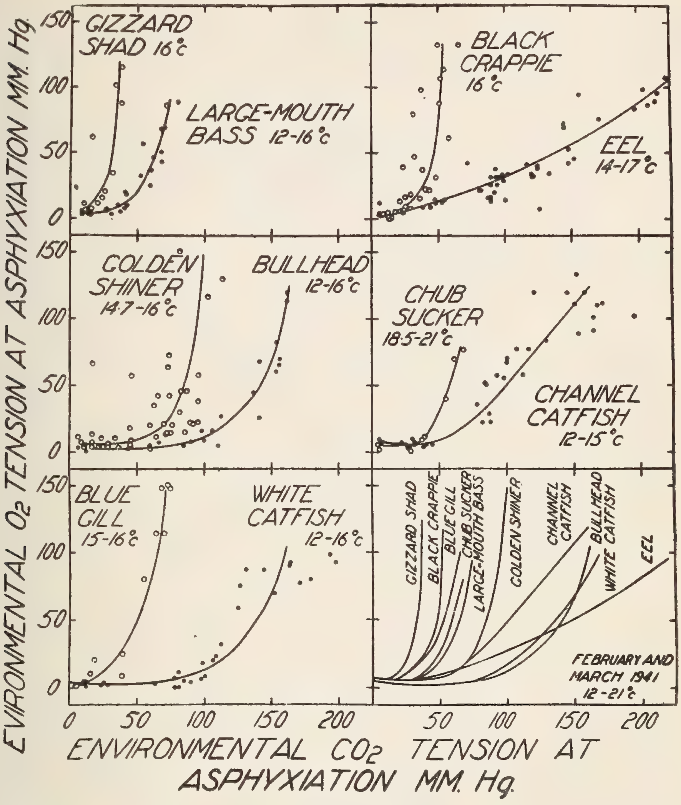

Fig. 1.—Specific differences in the oxygen tension remaining in the water after asphyxiation with different CO_2 tensions. In the first five panels are shown the data for the ten species, with two in each panel. In the lower right panel, the mean curves for the respiratory tolerance of the ten species are combined for comparison.

CIRCULATION

Stroke Output by the Ligation Method.—The rate of circulation of blood depends on the volume output of the heart per beat and on the frequency of the heart beat. Neither one of these factors has been measured on fish functioning normally. However, under experimental conditions the stroke output was measured to determine its magnitude and the extent to which it shows specific differences. The ligation method already described gives indirect information concerning stroke output under the conditions of the experiment, and is probably a fairly close approximation to the mean normal stroke output of the fishes tested. Individual variations in heart beat rate were not

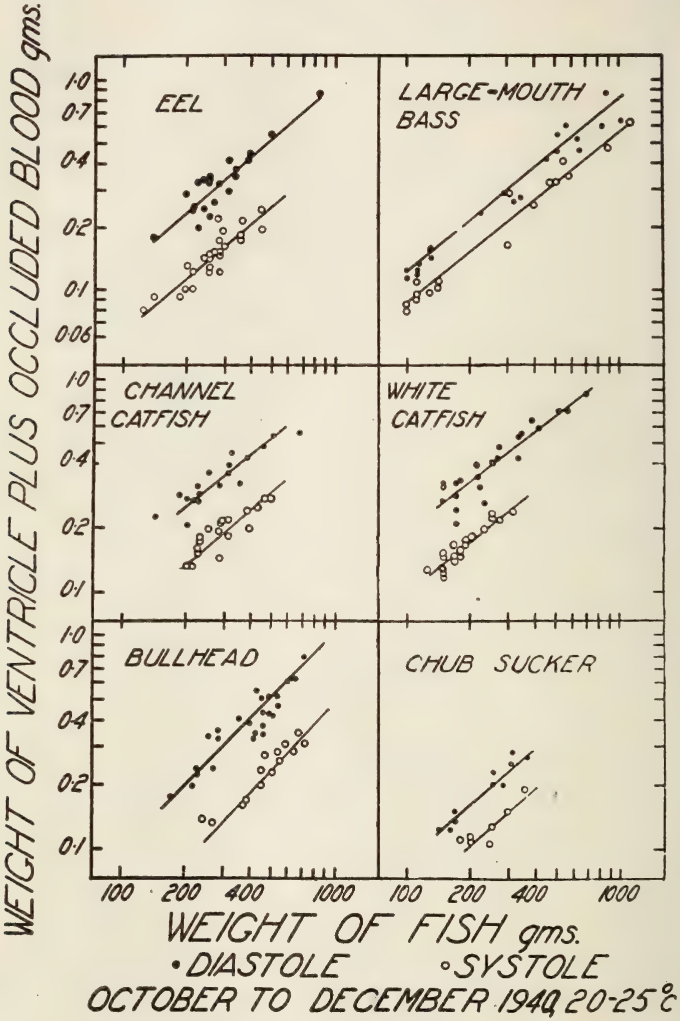

Fig. 2.—The weight of the ventricle plus occluded blood at diastole and systole as related to the body weight of the fish in six different species, double logarithmic grid. Tested October to December 1940, river temperature 20-25°C.

considered in these determinations. So far as is known there have been no previous determinations of stroke output in fishes except those previously made by the writer (Hart, MS).

By ligating and weighing the exposed ventricles of the species studied, and plotting the ventricle weights against the body weights on double logarithmic grid, two approximately parallel curves were found for each species (fig. 2). The stroke output was determined by subtracting the mean systolic weights (lower curve) from the mean diastolic weight (upper curve) for each species. The relation is linear on double logarithmic grid, indicating that the output is a function of body size (Huxley, 1932). The output at each size for each species is shown in Table 2.

TABLE 2—STROKE OUTPUT, LIGATION METHOD

SPECIES	Weight of Fish, grams.							
	200	300	400	500	600	700	800	900
	Stroke Output of the Heart, grams.							
Large-mouth bass	.055	.075	.095	.115	.135	.155	.175	.190
Chub sucker	.060	.085	.120					
Channel catfish	.115	.160	.190	.230	.265			
White catfish	.135	.170	.200	.240	.270			
Eel	.120	.170	.230	.270				
Bullhead catfish		.175	.230	.270	.320	.375		

Here again large differences occur between species (fig. 3). The catfishes and the eel have the greatest stroke output and large-mouth bass has the least; the former pump about 2.5 times as much blood per beat as the latter. The magnitude of the stroke output and the specific differences found in this series of fishes are quite similar to those of a series studied in Toronto, Ontario (Hart, MS). The Florida and Toronto bullheads, for example, both had an output of 0.27 gm of blood per beat at 500 gm body weight.

Blood Pressure.—The ligation method gives at best only an over all average for the stroke output of a given species of fish. The blood pressure was studied at different beat rates to obtain a better understanding of the influence of this factor (beat rate) on stroke output, and to determine whether or not blood pressure varies among the species examined.

Previous literature on the blood pressure of fishes has been concerned mostly with elasmobranchs. Schloenlein (1895) found a branchial systolic pressure of 16-18 mm of mercury for *Torpedo*

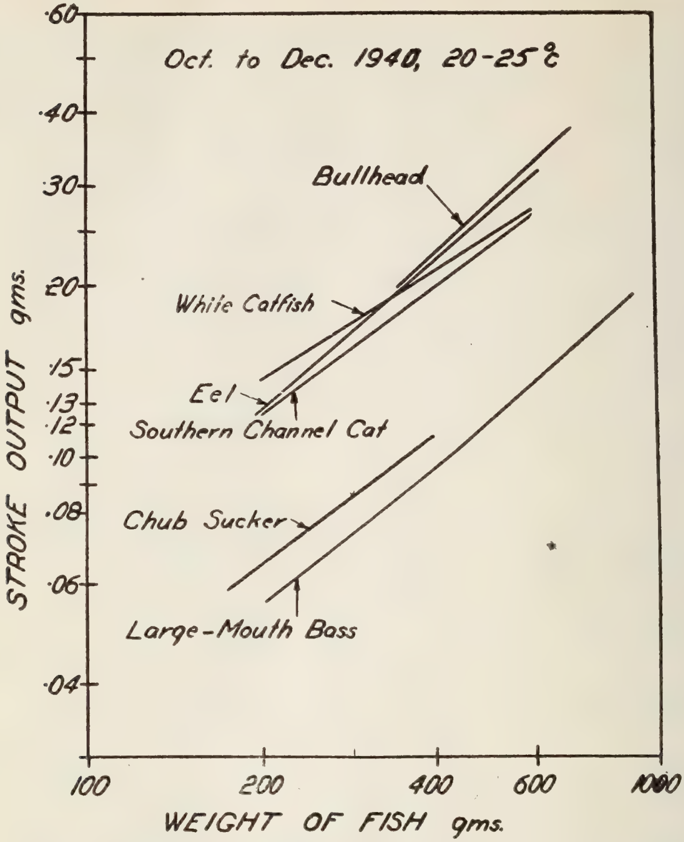

Fig. 3.—Specific differences in the stroke output at different body weights, double logarithmic grid.

and 30-33 mm for *Scyllium*. Hyde (1908) tested the effects of different salt solutions in water on the blood pressure of the skate, and found an average ventral aortic pressure of about 20 mm of mercury, while MacKay (1931) measured this pressure as only 13 mm Hg; the latter explained that differences in the experimental conditions in the two cases could account for the difference in results. Wyman and Lutz (1932) found in the dogfish an average ventral aortic pressure of 28.2 mm Hg, an average dorsal aortic pressure of 15.4 mm Hg. Lyon (1926), working with sand sharks, found an average ventral aortic pressure of 32 mm Hg, an average dorsal aortic pressure of 23 mm Hg. In a teleost, the Chinook salmon, Greene (1904) found enormously high pressures, from 30 to over 100 mm Hg, with beat rates varying from 20 to 90 per minute. He obtained some pressure readings as high as 172 mm Hg, and found that the heart during maximal work could double the normal blood pressure. It is evident from these results, even if the differences in methods employed make them not strictly comparable, that blood pressure is another highly variable factor in fishes.

In the present study the effect of beat rate on the blood pressure of four species was investigated in order to obtain some idea of the extent to which it is subject to specific variations. All

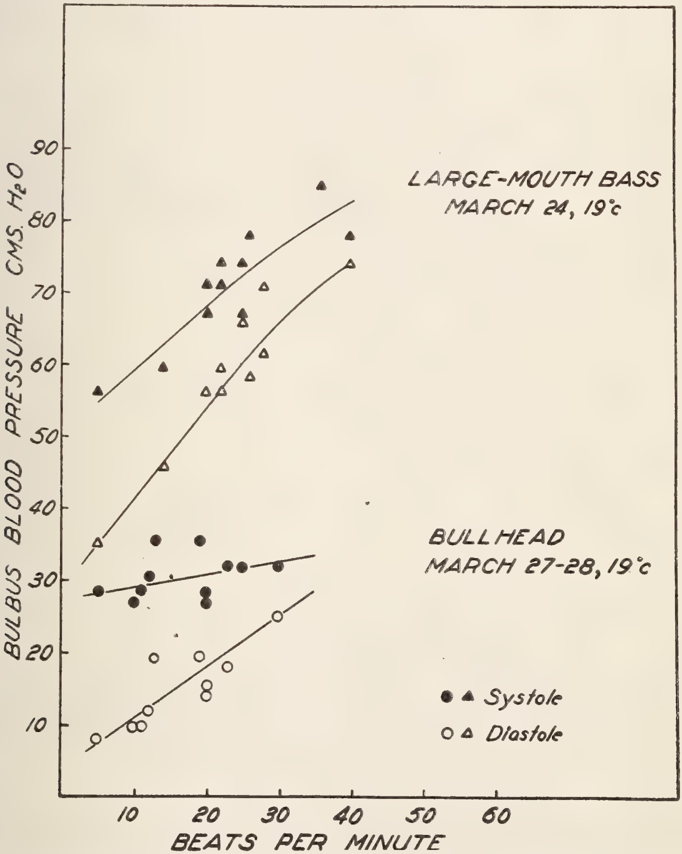

Fig. 4.—Blood pressures in the bulbus arteriosus at different beat rates in the large-mouth bass and bullhead. Solid marks are systolic pressures, open marks are diastolic pressures. Temperatures given are those of river at the time of measurement.

recordings were taken from the bulbus arteriosus so as to obtain pressures corresponding as nearly as possible to those in the ventricle without actually canulating the latter. As previously described (p. 225), a hypodermic needle fused to a capillary air

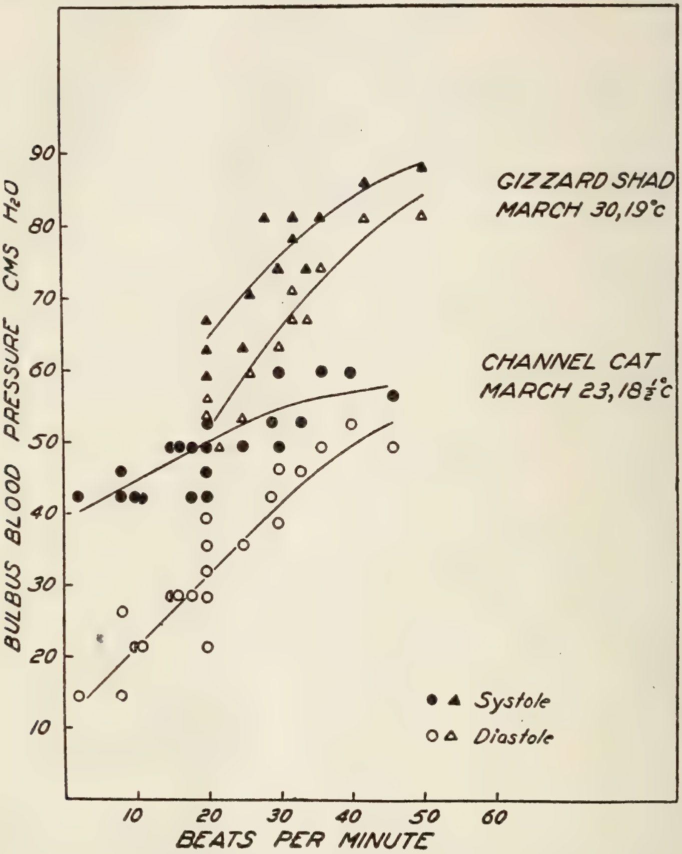

Fig. 5.—Blood pressure at different beat rates in the gizzard shad and channel catfish. Solid marks are systolic pressures, open marks are diastolic pressures. Temperatures given are those of the river at the time of measurement.

manometer of small volume was inserted through the wall of the bulbus arteriosus without otherwise interfering with the blood flow, which proceeded through the normal channels. The pressures recorded were the extreme ranges of the movement of blood in the manometer during systole and diastole, the differences between systolic and diastolic pressures being the pulse pressures.

In these fishes the beat rates were found to vary between 5 and 50 beats per minute from one individual to another, but the pressures proved to be closely correlated with rate of beat (Table 3; figs. 4, 5). At low beat rates (5 per minute) the pulse pressure is highest and systolic pressure lowest. As the beat rate increases the pulse pressure decreases while the systolic pressure increases. At high beat rates (40 to 50 per minute) the pulse pressure is lowest and the systolic pressure highest. So far as is known this is the first instance in which blood pressure has been correlated with heart beat rate in fishes. Greene (1904) gave data on blood pressure and beat rate in the Chinook salmon, but no consistent relation was found.

It has been established reasonably well for normally innervated hearts of dogs under conditions assuring effective venous pressure, that progressive acceleration above basal heart beat rates increases the mean arterial pressure and the output of blood per minute. The beat rate of maximal pressure is high (180-200 per minute), above which further increase in rate is accompanied by a fall of blood pressure and of output per minute. An increase in beat rate up to optimal rates is accompanied by an increase in diastolic pressure and decrease in pulse pressure (Shannon and Wiggers, 1939). In frog and turtle hearts the maximum pressure is reached at between 30 and 40 beats per minute. At higher beat

TABLE 3—BLOOD PRESSURE IN RELATION TO HEART BEAT RATE

Species	Gizzard Shad			Large-mouth Bass			Channel Catfish			Bullhead		
Date	March 30			March 26-27			March 26-27			March 27-28		
Aver. river Temperature	19°C.			19°C.			18°C.			19°C.		
Beat rate per minute	Blood Pressure in Centimeters of Water											
	D*	S*	P*	D	S	P	D	S	P	D	S	P
5				35	55	20	16	42	26	7	28	21
10				41	59	18	21	44	23	11	29	18
15				48	63	15	26	47	21	14	30	16
20	52	65	13	54	68	14	31	50	19	18	30	12
25	59	70	11	60	72	12	36	52	16	21	31	10
30	65	75	10	66	76	10	41	54	13	25	32	7
35	71	80	9	70	80	10	46	56	10	28	33	5
40	77	84	7	74	82	8	49	57	8			
45	81	86	5				53	58	5			
50	84	88	4									

*D = average diastolic pressure, S = average systolic pressure, P = average pulse pressure rates the blood pressure falls, and the output per minute would presumably also fall (Shannon and Wiggers, 1939). These results are very similar to those obtained in the present investigation with fishes, in which the blood pressure rises as the heart beat rate increases up to about 45 per minute; above this rate there would appear to be no prospect of any further great increase of pressure with increase in beat rate. The increase in pressure up to 45 or 50 beats per minute is presumably accompanied by an increase in output of blood per minute from the heart; beyond this point the output per minute may level off or fall with further increase in beat rate. This question is discussed later (p. 235).

The specific differences in blood pressure found by other workers have been mentioned above. It will be noted in Table 3 and figs. 4 and 5 that there are very large differences in the bulbus arteriosus blood pressure among the four species studied in this connection. Thus, at a heart beat rate of 20 per minute, the systolic blood pressure is 30 cm of water in the bullhead, and 50, 65, and 68 cm of water in the channel cat, gizzard shad, and large-mouth bass, respectively. The diastolic pressures vary in a similar but not identical way, since there is a considerable variation in the pulse pressure.

Stroke Output by the Manometer Method.—The manometer described above was used as an alternative means of determining stroke output to check the results of the ligation method, and to obtain some information about the variations in stroke output caused by differences in beat rate and blood pressure. This method gives many stroke output readings for each fish tested, and as stated above these get progressively smaller as the blood rises in the manometer tube. This was at first attributed entirely to the increase in pressure caused by the rising of the blood towards the manometer bulb; and in fact, when the stroke output is plotted against the corresponding manometer pressure a practically linear relationship is found to exist in all instances (fig. 6), indicating that the decrease in stroke output is caused by the increase in pressure (fig. 6). However, other factors than pressure appear to play some part here. The data presented in fig. 6 are merely representative, each curve recording the figures for one individual fish; actually 11 large-mouth bass, 12 gizzard shad, 23 channel catfish, and 7 bullheads were tested.

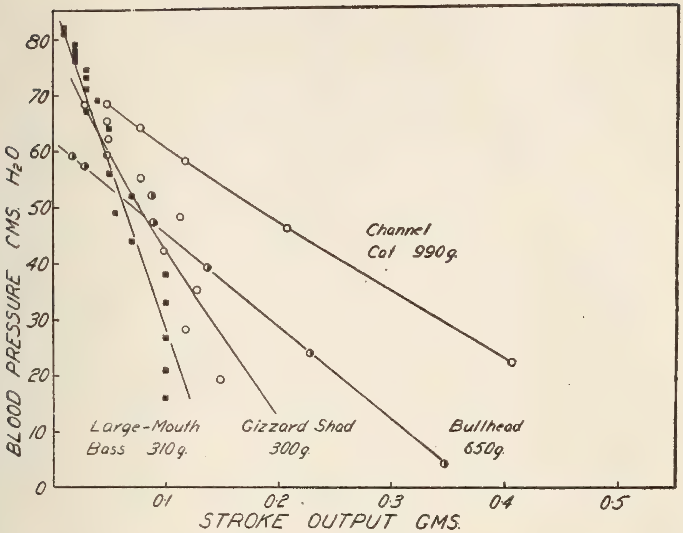

Fig. 6.—The relation between the stroke output and manometer pressure in a large-mouth bass, gizzard shad, bullhead, and southern channel catfish, determined by deflecting the blood from the bulbus into a manometer, and recording the volume of blood pumped and the pressure at each beat of the heart.

In order to compare the stroke output obtained by the manometer method with that obtained by the ligature method, the blood pressure and beat rate must be considered. The channel catfish is the only species in which enough data were obtained for this purpose; in it the average beat rate, before ligation of the hearts weighed to determine stroke output, was 18 beats per minute. This corresponds to a diastolic pressure of 29 cm of water (see fig. 5). Now if the stroke output at 29 cm pressure, determined for each channel catfish by the manometric method, is plotted against the body weight of the fish, the output is again seen to be proportional to body size (fig. 7). It will be noted that most of the higher beat rates are found where the output is small, and most of the low beat rates where the output is large. Two lines have been drawn, one through the points averaging 20 beats per minute, and another through the points averaging 43 beats per minute. It is evident that in the channel catfish the stroke output is lower at

43 beats per minute than at 20 even though the same pressure was used for plotting all the points (29 cm of water). In the following table the stroke output at 20 beats per minute (derived from fig. 7) is compared with that obtained by the ligation method where the beat rate averaged 18 per minute. The values obtained for the stroke output by these two methods agree remarkably well.

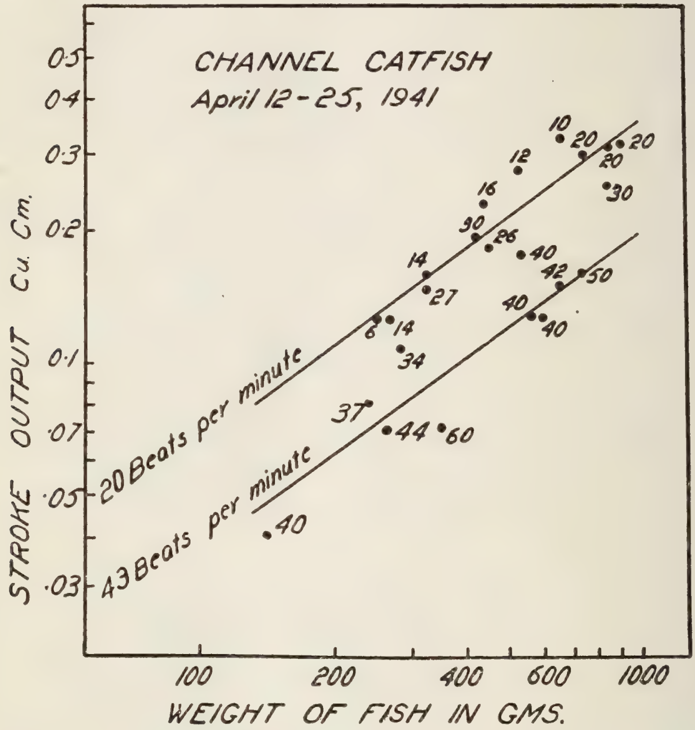

Fig. 7.—The relation between stroke output, beat rate and body weight of the southern channel catfish, determined by the manometer method at a diastolic pressure of 29 cm of water. The numbers above the points refer to the heart beat rates, and show that the faster the hearts beat the smaller is the stroke output. Double logarithmic grid.

TABLE 4—STROKE OUTPUT OF THE CHANNEL CATFISH

		Weight of Fish (grams)								
		200	300	400	500	600	700	800	900	1000
	Aver. beat rate per min.	Stroke Output at 29 cm Water Pressure								
Ligation Method (gm)	18	.115	.160	.190	.230	.265				
Volumetric Method (cc)	20	.11	.15	.18	.22	.25	.28	.30	.33	.36

It his been shown here, (page 234) that certain species (gizzard shad, large-mouth bass) have consistently higher blood pressures than others (channel catfish and bullhead). The question arises as to whether or not the quantities of blood pumped at various pressures always bear the same ratio in these species. To answer this question the stroke output-pressure curves for all the individuals of each species have been combined and the species compared on a common basis. To do this the output at 30 cm pressure in each species was arbitrarily taken as 100, and the other readings changed proportionally. In this way all the readings for a species can be plotted about a single line. These plots are shown in figs. 8 and 9, and it will be seen that there are specific differences in the degree to which the stroke output decreases as the pressure increases in the manometer. In the large-mouth bass (fig. 8) zero output is not reached until the pressure is 85 cm of water, whereas zero output is reached at 57 cm in the bullhead. However, at low pressures the bullhead possesses the ability to pump relatively much greater quantities of blood per beat than the large-mouth bass. Thus the large-mouth bass, with a low stroke output and a high bulbus pressure, has the ability to pump

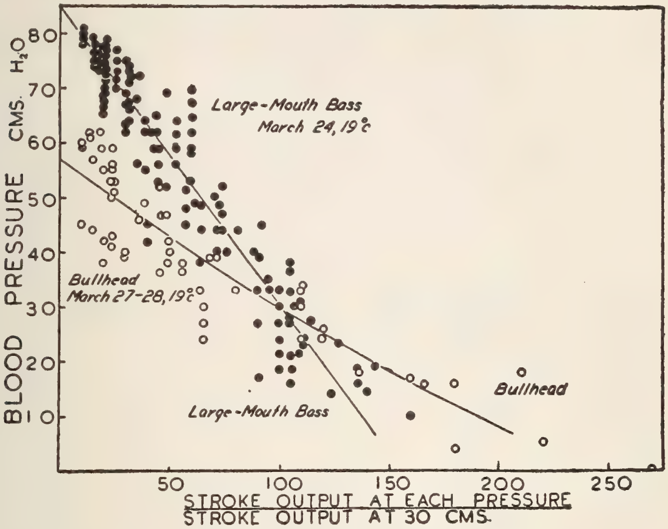

Fig. 8.—The stroke output determined at different pressures (by deflecting the blood from the bulbus into a manometer) is divided by the output at an arbitrary pressure of 30 cm of water to compare the relative ability of large-mouth bass and bullhead hearts to pump blood at different pressures.

small amounts of blood at relatively high pressures; whereas the bullhead has the ability to pump large amounts at low pressures only, and cannot pump even small amounts of blood at pressures above 60 cm of water. The gizzard shad and channel catfish do not differ greatly in their ability to pump blood at different pressures (fig. 9) although the gizzard shad has a much higher pressure system than the channel cat (fig. 5).

If it is assumed that the decrease in stroke output as the blood rises in the manometer tube is entirely a result of the increase in pressure, then one has to explain a paradox, because the "relative" output per minute, when calculated from manometer readings, actually decreases in the two species above 20 beats per minute (fig. 10, gizzard shad and large-mouth bass). That this is impossible is evident when the blood pressure curves for these species are considered, since the latter increases at rates above 20 beats per minute (figs. 4 and 5), and hence the output per minute would also have to increase to account for this increase in blood pressure. The obvious answer is that the stroke output does not decrease nearly as much as manometer readings would lead one to believe. Some other factor may also cause the stroke output to decrease as

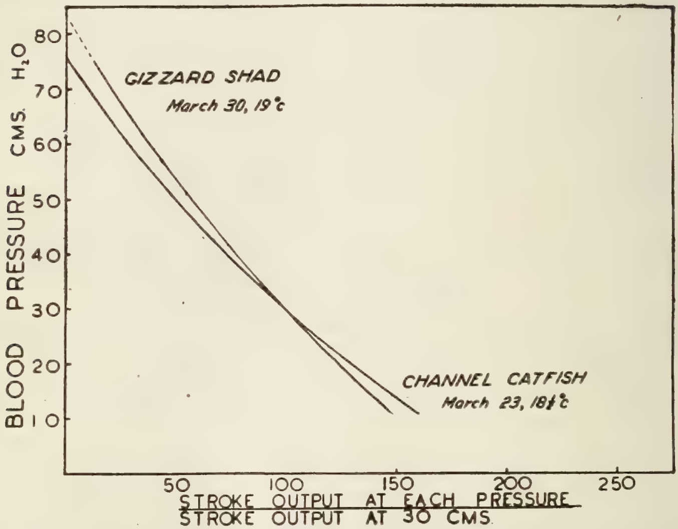

Fig. 9.—The stroke output determined at different pressures (by deflecting the blood from the bulbus into a manometer) is divided by the output at an arbitrary pressure of 30 cm of water to compare the relative ability of channel catfish and gizzard shad hearts to pump blood at different pressures.

the blood mounts in the tube. Although an increase in beat rate and blood pressure undoubtedly reduces the stroke output (fig. 7), the actual extent of this reduction is as yet uncertain. However, it is perhaps significant that the relative outputs per minute of these four species, calculated from manometer readings (fig. 10) bear the same ratio to one another as do the stroke outputs of these species determined by the ligation method. That is, the bullhead still has the largest output of all, and is followed in turn by channel catfish, large-mouth bass, and gizzard shad.

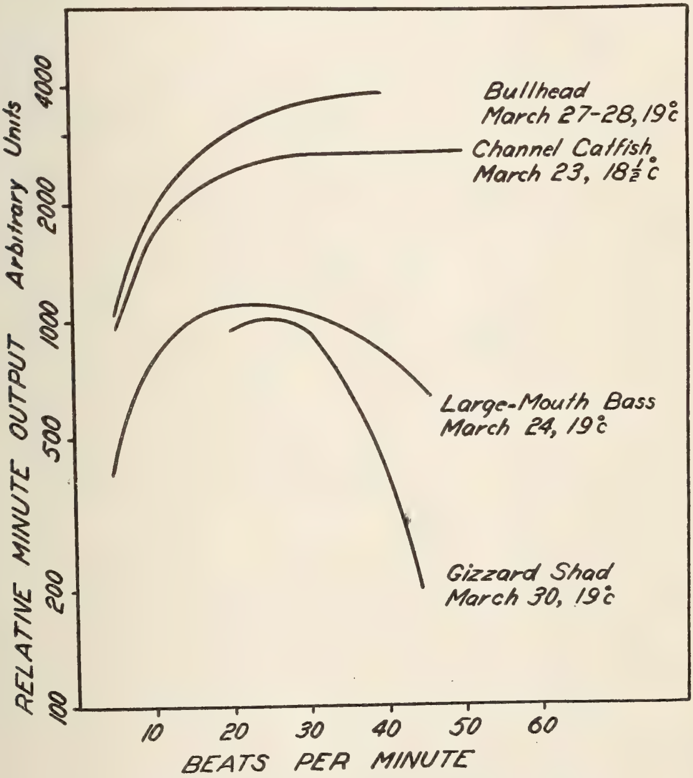

Fig. 10.—The relative output per minute at different beat rates in the bullhead, southern channel catfish, large-mouth bass, and gizzard shad. The relative outputs at each beat rate are obtained by calculating the diastolic bulbus pressures at those rates, and from the pressures thus obtained, the stroke output is estimated from Figs. 8 and 9. The stroke output units in figs. 8 and 9 are arbitrary, and when multiplied by 60 give values for the relative outputs per minute which also are in arbitrary units.

Discussion

The species tested in this study were found to show graded differences in four physiological respects: (1) tolerance to carbon dioxide, (2) stroke output of the heart, (3) blood pressure, and (4) effect of beat rate on stroke output and blood pressure. In the light of what has been demonstrated by other workers the large differences among the species studied are not surprising. Fishes as a group live under numerous types of environmental conditions and species have been shown to differ in almost every physiological respect.

So far, only a few of these properties have been measured in the same series of fish under the same conditions of time and place. It had been the object of this investigation to conform to this ideal, but in practice it was impossible to carry out. The stroke output was measured from October to December, 1940, the respiratory tolerance was measured in February and March, 1941, while the blood pressure and its effect on stroke output were measured still later in the season. Even under these conditions, however, there is an indication of the way in which one physiological factor differing greatly in two kinds of fish may compensate for another factor, the combined effect being to tend to equalize the physiological performance of the two species. Thus the oxygen transport capacity of the blood of species A may greatly exceed that of species B by virtue of its greater carbon dioxide effect, but on the other hand species B may circulate its blood at a faster rate than species A, the net result being that the oxygen transport in A and B is nearly equalized.

It has been shown by Black (1940) that fish possessing blood sensitive to CO_2 may unload more oxygen to the tissues for equal venous CO_2 tensions and equal volumes of blood than fish possessing blood tolerant to CO_2. The increased CO_2 sensitivity of the blood of certain species was thought to enhance its use in transporting oxygen by making available a higher pressure of oxygen at unloading; but this sensitivity would also hinder oxygenation at the gills. Fry and Black (1938) found that the common sucker with its CO_2-sensitive blood was unable to remove oxygen from water containing CO_2 tensions which did not hinder the respiration of bullheads; the latter possessed blood with a very low sensitivity to CO_2. However respiratory tolerance is not always related to the CO_2-sensitivity of the blood; species with a high tolerance have been found which possess a moderately high sensitivity to CO_2.

It appears from the results of the present investigation that the amount of blood circulated in a given time is greatest in species with a high respiratory tolerance and least in species with a low respiratory tolerance (Table 5). The relation between stroke output and tolerance is shown in fig. 11. A similar relation between stroke output and CO_2-sensitivity of the blood has been described previously (Hart, MS) for the bullhead catfish, carp, bowfin, and sucker. It is thus possible that the increased rate of circulation possessed by the catfishes, carp, bowfin, and eel, may tend to offset the disadvantages to oxygen transport imposed by blood with high tolerance to CO_2 in certain of these species and by high respiratory tolerance in others. Further work will be needed to settle this question.

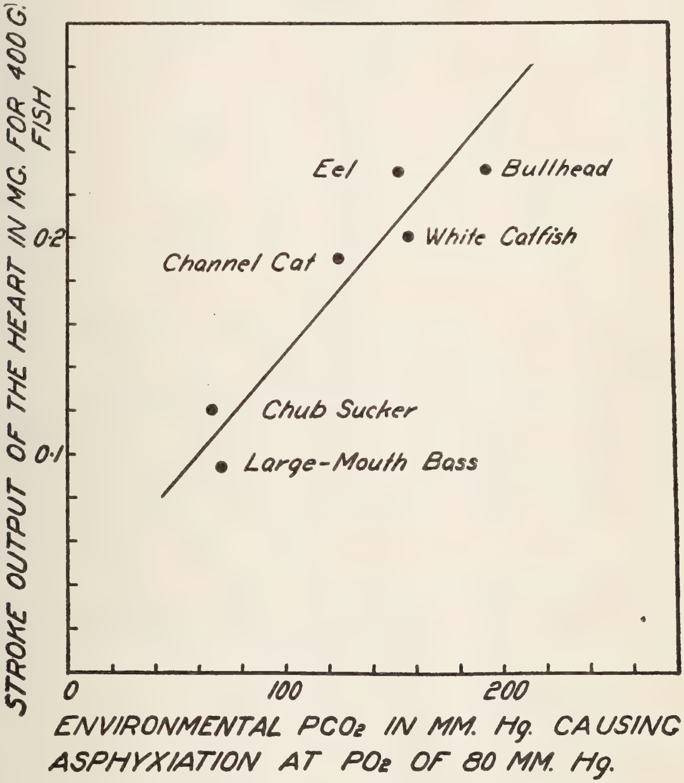

Fig. 11.—The relation between the environmental tension of CO_2 at asphyxiation with 80 mm O_2 in the water, to the stroke output in the bullhead, channel catfish, large-mouth bass, and gizzard shad, obtained by ligation.

TABLE 5—SUMMARY OF DATA

SPECIES	Environmental CO_2, mm Hg at asphyxiation in the presence of an O_2 pressure of 80 mm Hg.	Mean Stroke Output in mg for 400 gram fish, determined by ligation.	Diastolic blood pressure (cm of water) for 400 gram fish at 20 beats per min.
Gizzard Shad	35		52
Large-mouth Bass	70	.095	54
Chub Sucker	66	.100	
Florida Golden Shiner	92		
Southern Channel Catfish	126	.195	31
White Catfish	158	.210	
Bullhead	156	.225	18
Eel	196		

Further light is thrown on the circulation question when the blood pressure studies of the gizzard shad, large-mouth bass, channel catfish and bullhead are considered. Here again there is a correlation between the stroke output and blood pressure (Table 5). The situation is as follows: The CO_2-sensitive fishes (gizzard shad and large-mouth bass) have the highest bulbus blood pressure and the smallest stroke output, whereas the fish most tolerant to CO_2 (the bullhead) has the lowest bulbus blood pressure and the largest stroke output. The channel catfish was less tolerant to CO_2 than the bullhead, but more tolerant than the large-mouth bass. It was also intermediate with respect to blood pressure and stroke output. In these cases the CO_2-sensitive species (gizzard shad and large-mouth bass) possess a high pressure system with a small stroke output, and the CO_2-tolerant species possess low pressure systems with a large stroke output.

It was pointed out above that in the bullhead the ventricle was unable to pump blood at pressures which often occurred normally in gizzard shad and bass hearts, and that if the rate of circulation (relative output per minute) of the four species was calculated from blood pressure studies, the order was the same as that indicated from the stroke output measurements by the ligation method. The relation of these physiological differences to the environment of the fish will now be considered.

At Lake Opeongo in Algonquin Park, Ontario, sufficient data have been gathered to indicate that both the tolerance to CO_2 and stroke output are correlated with the vertical distribution of the species studied in the summer months. The deep water species inhabit cold water, possess a low tolerance to CO_2, and have a small stroke output. In shallow water are found fishes hardy with respect to CO_2 and ones which have a large stroke output. All intermediates occur.

At Welaka, Florida, no correlation could be found with vertical distribution or temperature, since the St. Johns River is shallow and homothermous. The fishes appear to live under equal temperature conditions, yet they display all the degrees of interspecific variation with respect to tolerance to CO_2, stroke output and blood pressure, that are found in Lake Opeongo. The reason is unknown. It is felt that the problem can be solved only by a thorough investigation of the distribution of fishes in the St. Johns River, and that measurement of both environmental factors and physiological factors of the fish must be carried out simultaneously.

SUMMARY

(1) The respiratory tolerance of 10 species of Florida freshwater fishes was measured. The species used were the gizzard shad, black crappie, eastern bluegill, large-mouth bass, chub sucker, Florida golden shiner, white catfish, southern channel catfish, marbled brown bullhead catfish, and American eel. Significant specific differences were found.

(2) The stroke output of the heart was determined in the case of the large-mouth bass, chub sucker, white catfish, southern channel catfish, marbled brown bullhead catfish and American eel. The output was determined by ligating and weighing the exposed ventricles of the fish. The stroke output thus obtained is the difference between the mean systolic weights and the mean diastolic weights for each species. Significant differences between species were found.

(3) The stroke output of the channel catfish was also determined by measuring the volume of blood pumped at each beat with an air manometer. At 20 beats per minute the values are similar to those obtained by the ligation method, where the beat rate averaged 18 per minute. In this species the stroke output is lowest at the higher beat rates.

(4) The systolic, diastolic and pulse pressures in the bulbus arteriosus of the gizzard shad, large-mouth bass, southern channel catfish, and bull head were measured by mercury and air manometers. Significant specific differences were again found. The

blood pressure in each species is correlated with the beat rate of the heart; as the beat rate increases the blood pressure increases and pulse pressure decreases.

(5) The stroke output is greatest in the species with low blood pressure and least in the species with high blood pressure.

(6) Significant specific differences were found in the ability to pump blood against varying pressures. When the pressure reaches 57 cm of water the bullhead is unable to pass any blood through its heart, whereas the large-mouth bass is able to pass blood up to a pressure of 85 cm of water.

(7) The species with a high respiratory tolerance possess a large stroke output and a low blood pressure system (southern channel catfish and bullhead). The species with a low respiratory tolerance possess a small stroke output and a high pressure system (gizzard shad and large-mouth bass).

(8) A possible relation between the mechanical and chemical transport of oxygen and the environment of the species is discussed.

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LIFE HISTORY NOTES ON THE FLORIDA WEASEL

JOSEPH C. MOORE

Lt. (jg), USNR

This paper grew out of an accumulation of notes made on a captive Florida weasel, to which have been added other available data on the natural history of the species from a variety of sources. In form it follows largely the pattern used by Seton in his "*Lives of Game Animals.*"

I wish to acknowledge my indebtedness to Professor H. B. Sherman of the Department of Biology, University of Florida, for much constructive criticism of the manuscript, for extensive use of his personal library, and for photographs of the weasel (figs. 1, 2). I wish also to thank Mr. J. C. Dickinson for the generous gift of the live weasel with which much of this paper is concerned. Major Allan Brooks of Okanagan Landing, B. C., Mr. E. Ross Allen of Ocala, Florida, several citizens of Welaka, Florida, and others supplied helpful information which is here gratefully acknowledged. The observations here recorded were made while I was holder of a graduate scholarship in the University of Florida.

Synonymy.—The Florida weasel was originally described by Rhoads (1894: 152-55) as *Putorius peninsulae.* The generic name *Putorius* has since been replaced by *Mustela.* The Alabama weasel was described by Howell (1913) as *Mustela peninsulae olivacea.* Some time later Hall (1936: 105) synonymized *peninsulae* under the species *frenata,* so that the Alabama and Florida weasels now bear the names *Mustela frenata olivacea* and *M. f. peninsulae* respectively.

Range.—According to Hall (*l.c.*) the range of the Florida race *peninsulae* is "Austral and probably Tropical zones of Florida south of 29°N. latitude." Weasels collected by Harper in the Okefinokee Swamp were referred to race *olivacea* with some hesitation by Howell, "who remarks on the difficulty of determining specimens owing to the lack of material representing typical *peninsulae.*" (Harper, 1927: 305). Since the ranges of these two subspecies and the extent of intergradation between them are still uncertain, information concerning weasels from Florida and the Okefinokee Swamp of Georgia is pertinent to the present discussion.

In the literature through the year 1942, weasels are recorded from the following localities in Florida: ''Hudsons,'' Pasco Co. (Rhoads, 1894: 152); Tarpon Springs, Pinellas Co. (Merriam, 1896: 19); Osceola, Seminole Co. (Chapman, 1894: 345); Enterprise, Volusia Co. (Elliot, 1901: 55); Hicoria, Highlands Co. (Rand and Höst, 1942: 5); and Gainesville, Alachua Co. (Bangs, 1896: 232; Sherman, 1929: 258). Evidence of the occurrence of weasels in four other counties in Florida is as follows:

Brevard County: Major Allan Brooks (letter, May 11, 1942) writes: ''The only weasel I ever saw in Florida was three miles north of Melbourne on the main road to Eau Gallie, 31 Dec. 1920; it was a large well-colored male and crossed the road 15 yards ahead of me quite slowly . . . ''[1]

Putnam County: I have seen the skin of a weasel at Interlachen, the property of Mr. Roy Martin, who stated that it was caught in that vicinity. Mr. S. L. Shepherd of Pomona saw a weasel cross the road in front of his car at night between Crescent City and Huntington about 1932. Mr. L. A. Morris, octogenarian resident of Welaka, whose memory is of excellent reputation, tells me of a weasel which the late Jim Fowler of Welaka took in a trapline set out for raccoons and opossums along Mud Spring Run about 1925, on land which is now a part of the University of Florida Conservation Reserve. Myron Warr of Welaka tells me that he killed a weasel with a stick in his mother's chicken house in Welaka about 1928 or 1929.

Gadsden County: Mr. Shepherd also tells me of weasels which appeared occasionally about the buildings on his father's farm near Quincy, and which worked havoc among the rats which accumulated in the buildings between visits of the weasels.

Marion County: Ross Allen, the naturalist of Silver Springs (in letter, Sept. 11, 1942), writes, ''I have personally collected only 12 weasels, all in Marion County. All but three were taken in the Ocala National Forest [between 1934 and 1942] while trapping for other animals.'' Mrs. L. A. Morris of Welaka, Putnam County, says that some 40 years ago weasels were occasionally seen on her father's (John McRae's) farm near Salt Springs, Marion County, which is now in the Ocala National Forest.

Haunts or Habitat Preferences.—According to the records available the Floria weasel displays no distinct preference for any one type of vegetational habitat. Its habitat preference is probably best expressed as the sum of the habitat preferences of the small mammals upon which it preys.

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[1] This is mentioned in Dr. Thomas Barbour's book, *"That Vanishing Eden,"* (1944), on p. 135; he also records a male *M. peninsulae* from Gilchrist Co., Florida.—Editor.

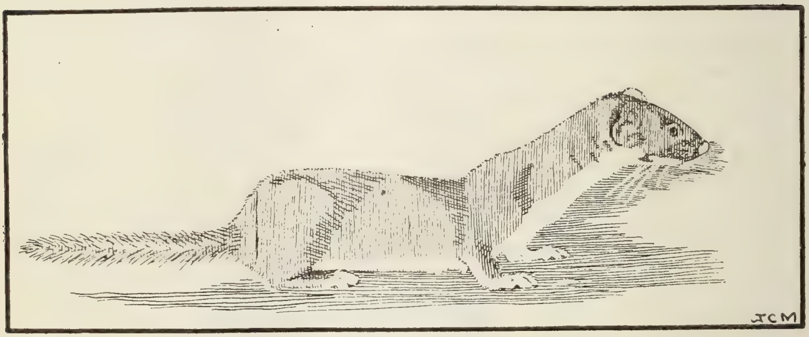
Sherman (1929: 258-9) caught a weasel at Gainesville in a pocket-gopher trap, ''set at an opening of a pocket-gopher burrow which had been exposed by digging about a foot below the surface in a scrub oak habitat.'' The captive weasel to be discussed in the present paper was also taken in a pocket-gopher burrow, and Florine (1942: 213) trapped a specimen of another race of *Mustela frenata* in a pocket-gopher tunnel in Minnesota. Rand and Höst (1942: 5) mention a Florida weasel seen in the ''sand scrub country,'' Highland County, Florida. Harper (1927: 301), in discussing the mammals of the Okefinokee Swamp, writes, ''This weasel seems to live principally in the cypress bays, branch swamps, pine barrens, and cypress ponds.'' The individual which Major Brooks saw in Brevard County came '' . . . out of the palmetto scrub.'' Ross Allen (in letter) mentions two which apparently came from the cypress swamp near his Silver Springs workshop.

Numbers.—The scarcity of sight records by men who spend much of their time afield forces one to conclude that the weasel is either strictly nocturnal or somewhat rare. The fact that experienced trappers seldom catch them is dubious evidence of their scarcity, because fur trappers confine their operations largely to swamps, where raccoon, opossum, and otter are most numerous. And, as Edward Palmer of Welaka remarked to me, ''A weasel is most too light to throw our 'coon and 'possum sets.''

A. H. Howell (1921: 36) states, ''Weasels are apparently scarce everywhere in the southern states . . . '' Harper (1927: 301) considers the weasel ''rather uncommon'' in the Okefinokee region. Henry Waller, a trapper of some experience in the swamps of the St. Johns and Oklawaha rivers, tells me that he has never seen a weasel and cannot recollect a specific instance of anyone else encountering one. Rand and Höst (*l.c.*) report that in nine and one-half years of ''vermin control'' at Hicoria, Highlands County, there were trapped 106 opossums, 53 skunks, 52 foxes, and 42 house-cats, but only 2 weasels, perhaps indicating that weasels are rare in that locality. Bangs (1898: 232) on the other hand remarks: ''The Florida weasel is by no means rare throughout peninsular Florida. It is one of the most difficult animals to trap; indeed no one has ever been able to trap it successfully. . . . I wasted more time in a vain endeavor to trap it there [at Gainesville] than I ever did over any other animal.''

Breeding.—Harper (1927: 303) quotes one of the men of the Okefinokee region who had found a weasel family. "It was in the early part of the winter of 1917 when I found them. Their den was in the trunk of a hollow cypress tree . . . In the den were the mother and three young ones . . . I found one of the little ones before I saw the old one . . . but kept on cutting until I found the old one and killed her. I succeeded in finding two more young ones as I was searching the bed. They were about the size of mice. I gave them milk for a few days, and then fresh meat. They grew up very fast . . . " Another of these men, according to Harper (p. 304) found a den of weasels about November. There were three young about half grown in the den.

The weasel which I obtained at Gainesville appeared to have attained full growth about the last of February. Since Seton (1926) shows that long-tailed weasels of the north are born in late April or May, and assumes that they attain full size in late August or September, we may estimate the age at which these animals reach full size at four months. Applied to my weasel this would place its birth date in the last part of October or early November. This, with the data on the two families recorded by Harper, seems fairly clear evidence that the young of the Florida weasel are born in late fall or early winter.



A Captive Weasel.—The weasel upon which my observations were based was a male, captured January 5, 1940, in the drug garden of the University of Florida; this garden is situated on low ground, bordered by a moist and in places swampy hammock. The manner in which it was taken alive is probably unique. The colored caretaker, Ferguson, observed the animal thrusting its head curiously out of a pocket-gopher hole. According to his story, he lashed a large fish-hook to the end of a fishing pole and slid it gently down into the hole. When, after a time, the weasel crept up past the hook to peer out, the man snagged it, dragged it forth, and imprisoned it in a bread can. The weasel was then given to Mr. J. C. Dickinson, a fellow student, who in turn generously gave it to me. This captive is the weasel referred to in the remainder of this paper, unless otherwise specified.

Size and Growth.—When first caught the weasel had a definitely juvenile appearance. Toward the last days of its captivity it seemed much more fully developed in both physique and behavior, though its testes did not become prominent at any time. During 65 of its 71 days of captivity it grew 43 mm in total length. The following measurements were taken in the usual manner (Anthony, 1931: 21-25.)

TABLE 1—GROWTH OF A CAPTIVE WEASEL

Date	Total length (mm)	Tail length (mm)	Hind foot (mm)	Ear (mm)	Weight (gm)
Jan. 11	377	120	47	13	not taken
Feb. 17	415	145	48	13	324.5
Mar. 16	420	148	48	13	319.7

Merriam (1896: 19) records an adult female from Tarpon Springs with the following measurements: total length, 374 mm; tail, 127 mm; hind foot, 44.5 mm.

Denning.—At first the weasel was kept in a mouse cage which measured 13 x 9 x 9 in. This was constructed of hardware cloth with tin trays for top and bottom, and contained a wooden nest box 4 x 5 x 6 in. which had a door to keep the animal in or out while the cage or nest was being cleaned. Eventually the weasel was transferred to a larger cage measuring 20 x 14 x 12 in. This had no nest box, but the weasel appeared content to sleep curled up in the excelsior, oak leaves, or Spanish moss furnished for bedding. It frequently slept with the fore part of its body turned ventral side up, showing its creamy underparts. Often, when lying partly upon its back in this way, it held one of its front paws cocked up in the air and drooping at the wrist.

Toward the end of its captivity the weasel was permitted to run freely about the floor of the room. After it had tired of scampering, it went to the nest box of an unoccupied mouse cage (like the one it had lived in at first), and there curled up to sleep, allowing itself to be shut up for the rest of the night. After it had done this once, the same nest box was prepared with a bed of excelsior and was used by the weasel on other such occasions.

In the Okefinokee Swamp the weasel, according to Harper (*l.c.*), nests in hollow trees and logs in the swamp, cypress bays, and pine barrens.

Food.—Bang's statement (1898: 232) that the Florida weasel apparently lives on cotton rats (*Sigmodon*) is partly supported by Harper's informant (1927: 304), who found in a weasel's brood-nest " 'pretty near a peck er Wood Rats,' whole and in pieces, remains of 'all kinds er birds—Robins, Quail an' maybe others; an' a piece er Joint Snake . . . about 4 inches long.' " ["Wood rats" meant *Sigmodon* in this instance]. Another nest (p. 303) contained three *Neotoma*, two *Sigmodon*, and "a bushel or more of rabbit hair, rat hair, and squirrel hair." The comparative numbers of *Sigmodon* in the two nests may be partly accounted for by the fact that the first was located in flatwoods, the second in the swamp; for cotton rats do not inhabit heavy swamp forests in any numbers but are abundant in the flatwoods near ponds and streams.

Live cotton rats were commonly provided for the captive weasel; it killed them as quickly and as mercifully as I could have. A list of the kinds of animals that the weasel ate follows:

Pocket-gopher	*Geomys tuza austrinus*
Harvest mouse	*Reithrodontomys humulis humulis*
Cotton mouse	*Peromyscus gossypinus gossypinus*
Golden mouse	*Peromyscus nuttalli aureolus*
Rice rat	*Oryzomys palustris natator*
Cotton rat	*Sigmodon hispidus hispidus*
Roof rat	*Rattus rattus alexandrinus*
Loggerhead shrike	*Lanius ludovicianus ludovicianus*
White-eyed vireo	*Vireo griseus griseus*

The weasel also ate sparingly of ground beefsteak and still more sparingly of fish. A salamander (*Pseudobranchus*) which was provided for food was ignored, and a common chicken snake (*Elaphe q. quadrivittata*) seemed most repugnant to it. During the weasel's first 18 days of captivity it ate an average of about 63 grams of flesh and blood daily. The food animals were weighed just before they were given to the weasel, and there was seldom anything left over from the meal. Sometimes a rat's foot or tail was found when the nest box was cleaned; the weights of these remnants were not recorded. The detailed list of the food of the weasel during this period is as follows:

TABLE 2—AMOUNT OF FOOD CONSUMED DURING EIGHTEEN DAYS

Date	*Animal*	*Weight* (*gm*)	*Date*	*Animal*	*Weight* (*gm*)
Jan. 5	Young rice rat	32	Jan. 15	Cotton mouse	30
6	Young rice rat	29	16	Cotton mouse	24
7	Vireo; cotton mouse		17	Ground beefsteak	
8	Pocket-gopher	198	18	Cotton rat	61
10	Cotton mouse	33	19	Cotton rat	63
11	Cotton rat	116	20	Cotton rat	62
12	Rice rat	90	21	Cotton rat	53
14	Cotton rat	105	22	Cotton rat	45

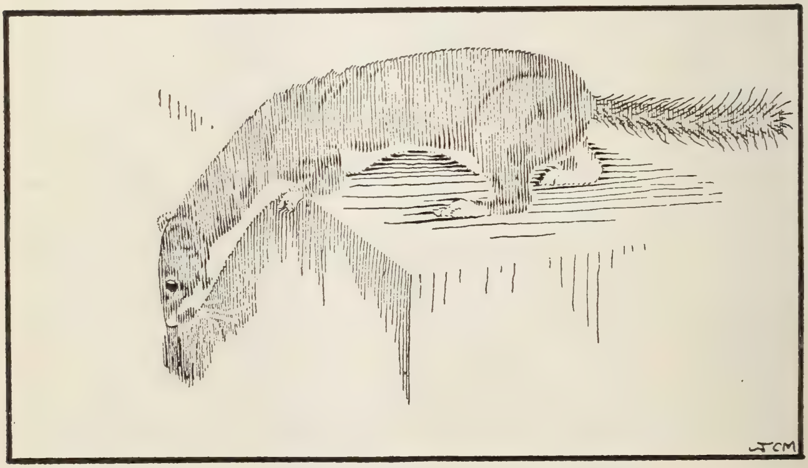
For the remainder of its period of captivity the weasel lived apparently well on a rather consistent ration of one cotton rat per day; the average weight of these was probably about 70 grams.

Feeding Behavior.—At first the weasel carried its prey into the nest box and ate it there, but after a few days it ate outside of the nest box where it could be watched. It invariably began at the base of the skull and ate the brain; then it usually progressed to the neck, shoulders, and on toward the tail, but this part of the procedure sometimes varied. Of the shrike it ate only the brain and part of the shoulders. The skull and most other bones of the prey were eaten, and in the droppings pieces of femora and other large bones, 15-20 mm long, were observed. Feet and tails were sometimes left uneaten, as well as an occasional patch of skin, and in the case of rice rats much of the fur was left.

Before mealtime the weasel was often permitted to romp and frolic about on the table and floor. Because it was habitually fed in its cage the animal could easily be attracted back in by the food, and was kept in the cage until its play-time the following day. Toward the last, when the weasel was allowed more freedom since I found that it permitted itself to be locked up at night anyhow, rats were sometimes still put in the cage in order to watch the weasel's actions in getting them out. It could barely jump up the 12 inches to the top of the cage with a large cotton rat in its mouth. This was necessarily a good clean jump, for a sheet-metal rim projecting in several inches at the top had to be cleared. The weasel seemed to want to eat its prey in the relative freedom of the open floor, although it was never allowed to do so. It drank freely and frequently, lapping daintily in the manner of a cat.

Sanitation.—When the weasel dragged its prey into the nest box, it ''messed up'' its bedding material with the body fluids and fur or feathers to such an extent that, for the sake of cleanliness, I provided new material every day. It had a habit of urinating and defecating on the top of its nest box during the first few weeks of its captivity. This may be considered a form of sanitation if one considers that the animal was placing the excreta where they would be least in the way in this small cage. When the weasel was moved to the larger cage, the finger-bowl water dish became the favorite receptacle for excreta. This, Seton (1925) points out, is also a sanitary habit, for in nature the stream or pond into which the excreta might be dropped (and for which the water dish was a substitute) provides sufficient dilution to amount to disinfection. And in the cage—was this not in fact the most efficient way of disposing of this material? The dish was actually removed and cleaned every day.

As time went on, however, the weasel became progressively less tidy in its habits, and dropped its scats promiscuously about in the bedding which covered the whole floor of its larger cage. Sometimes they were even found in the corner which the weasel had come to use regularly as a bed. They were usually soon stiff and dry externally, and I removed them daily with forceps. Can it be that the weasel's carelessness was increased by the fact that its droppings were disappearing and did not remain to cause annoyance, no matter where they were left? The bedding in the cage was replaced about once a week, and its floor was washed and scrubbed every two or three weeks. In a large pen the behavior of the animal relative to sanitation would very likely have been different.



Harper's informant (1927: 303) describes a weasel brood-nest which contained "'a bushel or more of rabbit hair, rat hair, and squirrel hair. It looked like it must have been used as a den for several years, although there was no stink that I could detect except the musk from the old weasel.'" Seton (1926: 591) states that his captive weasels "were careful always to keep a special corner of the cage for the dung . . ."

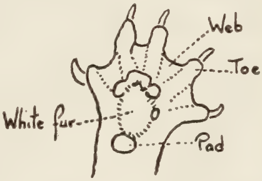
Odor.—In his "Lives of Game Animals" (p. 622) Seton refers to Audubon and Bachman, and to Merriam and Stejneger, for comments on the musk of long-tailed weasels. In each instance cited the animal was hurt, and emitted "an offensive odor" or a "powerful stench." Whenever my captive Florida weasel was frightened it gave vent to a strong, musky odor which fits the above descriptions, and which was often characterized even more forcefully by the people who shared the study room with the weasel and me. The animal seemed to emit musk during the night, or had musky urine or a strong body odor, for when the room had been closed over-night the atmosphere by morning fairly reeked with the smell.

Various Powers.—The ability of the weasel to jump over a 12 inch cage side with a large cotton rat in its jaws has been mentioned. It was seen to jump, unimpeded by prey, to the top of a box 20 inches high, and from the ease which the animal displayed in doing this, it seemed likely that it could have jumped several inches higher. The table on which were kept some caged mice was 30 inches high, and the weasel jumped to the top of a box and then to the table top in ardent efforts to get at them. When, to protect the mice, the box was removed, the weasel showed great eagerness to reach the table top but never essayed the 30 inch jump. Nor did it ever voluntarily jump down from the table, once up there. This fact, divined early, enabled both the weasel and me to enjoy his romping and cavorting on the table, without worry on my part as to whether I should be able to recapture and cage him.

The running speed of the weasel appeared to be very good for so short-legged a creature. Certainly it could run down a cotton rat with ease. It could also carry a large cotton rat in its jaws and run along at a good pace; but to do this, it had to hold its head very high to keep the rat from dragging under its feet, and progressed by a series of hops which were rather higher and shorter than usual.

The weasel was never given an opportunity to swim, but on one occasion it was seen at its drinking dish thrusting its head under water and making swimming motions with its fore paws. As this was on a hot day, the weasel may simply have been trying to cool himself. As shown in the accompanying figure, its paws are partly webbed in a manner which would be helpful in swimming.

Two observations were made on the weasel's power of following scent. Outside its cage a rat was released on the floor, and after it had hidden in a corner the weasel was freed. He seemed completely at a loss to trail the rat; but presently hearing it move, and then seeing it in motion, the weasel literally hurled himself upon it. On another occasion the weasel failed to find a cotton rat which it had just killed when I dragged the rat across the floor out of sight; the weasel was able to follow the scent rather hesitantly for only three or four feet. The floor was dry, dusty concrete.



Forefoot of Florida weasel, ventral aspect

The weasels of other parts of the country are well-known for their abilities as hunters and warriors. Audubon and Bachman (1851: 59) tell of using them with marked success to chase rabbits out of holes. Seton (1926: 630) quotes Charles Tatham, Jr., who wrote of a weasel attacking a rather large dog repeatedly until it lost its life in the dog's jaws, although it might have escaped easily. In the same work Seton (*l.c.*, p. 631) quotes J. Dewey Soper who credits a weasel with attacking a hawk, and despite being borne aloft, persisting in its effort to kill until it brought the hawk tumbling to the ground. Then it fled at the approach of the observer.

My Florida weasel did not perform such feats of courage as Seton relates, but it certainly lived up to the weasel tradition of fearlessness and fight. It killed a cotton mouse, cotton rat, or rice rat so quickly and easily that death by shooting could have been no more merciful for them. The weasel's behavior in accomplishing the killing, however, provided striking exhibits of skill and ferocity. While it was new to captivity, it watched for its chance to kill and then struck like an arrow. Its first grip was usually the death grip, and its paws rarely came into play. After the first few weeks, however, the weasel began to rush upon the prey with complete abandon the moment it was seen, and appeared to derive considerable joy from the ensuing struggle, momentary though it usually was. Seizing any part of the panic-stricken animal in its jaws, the weasel tackled it, hugging it up close in its arms like a football player recovering a fumbled ball. This enabled the weasel to shift its hold swiftly to the base of the victim's skull, whereupon the battle was immediately over, and the victor stood up holding its prey clear of the floor for a moment until it ceased to kick. As the weasel stood thus triumphant, the hair on the back of its neck stood erect, and its eyes seemed fairly to sparkle with ferocity.

On one occasion I expected to try the weasel's mettle by placing a large male pocket-gopher in the cage for it to eat. The pocket-gopher weighed about two-thirds as much as the weasel and was armed with formidably-protruding incisors and large digging claws. When the nest box door was raised, the weasel looked out at the hulking rodent and drew back. Presently the weasel's head shot out of the box. It seized the gopher's near hind leg, and jerked it to the door of the nest box. The gopher struggled bewilderedly for a minute while the weasel merely held its advantage. Then it began pulling, twisting and jerking, several times actually revolving on its own long axis as if to wrench the limb off. Suddenly it shifted its grip to the rather loose skin of the struggling gopher's side, and then in a moment more it had the rodent by the base of the skull. That was the end. The gopher had made no apparent effort to use its teeth or claws on the weasel, and its struggles to escape were awkward and ineffectual. That the weasel used the confining walls of its nest box to expert advantage in this encounter suggested that killing a pocket-gopher in the confines of its subterranean tunnels was an art not unknown to this particular animal (taken, one may recall, in a pocket-gopher burrow), nor to its kind in general. Long-tailed weasels have been trapped in pocket-gopher tunnels by Sherman (1929: 258-9) in Florida, and by Florine (1942: 213) in Minnesota.

Once a 36-inch chicken snake (*Elaphe q. quadrivittata*) was placed in the cage. Fear now showed in the weasel's behavior. Both animals appeared to feel cornered, and for some minutes one did about as much attacking as the other. However, the weasel rallied and flew at the serpent with repeated swift lunges which very nearly matched the reptile's own strike. It was apparent that the weasel was trying for the back of the snake's head, but the reptile's quickness and the smooth armor were a good defense. The snake struck repeatedly at the weasel's head and soon the latter's nose was bleeding slightly. Gradually the weasel began to prevail, however, and its sharp teeth scarified the scaly creature's neck. Shortly thereafter it was leaping upon the weakening snake and biting it repeatedly. The weasel never closed and wrestled with its antagonist, however, and even after the snake was dead it seemed still to inspire horror and revulsion in the mammal.

Ross Allen (in letter) tells of what was perhaps a more natural weasel-snake encounter. In January, 1940, someone suddenly called him out in front of his log cabin. There he found ''a sick-looking weasel running around as though in distress.'' On picking the animal up he found that it had a large swelling in its side. It died after a few hours, and upon being skinned showed a blood clot which ''indicated that the cause of death was snakebite. Apparently the weasel had attacked a moccasin. I say moccasin because that is about the only snake it would find in the swamp nearby.''

Voice.—During the first week of captivity the weasel frequently gave voice to an odd little bark which might be described as, ''Erp, erp, erp, erp!'' The significance of this was not apparent. The sound was uttered as the weasel looped back and forth within the confines of the cage. Later, on several occasions when the weasel was being punished or threatened with punishment while confined in the cage, it made a warning sound which may be imitated by shaping the mouth as if to say, ''haaaaaa,'' (the ''a's'' sounded as in hand), and then simply expelling the breath sharply for two or three seconds. The resulting sound is similar to, but less explosive and more prolonged than one which I have heard a laborer make when striking blows with an ax or a pick.

Toilet and Health.—Although the weasel was somewhat ''messy'' about its nest box and cage, as has been mentioned, it always kept its coat and tail clean. It was sometimes seen licking its fur in the manner of a cat.

When captured, the weasel was hooked somewhere on the under side of the body. It was handled roughly with gloves in being transferred from the bread can to the cage, and when it was in the cage, the gentleman who gave it to me shook the creature up, trying to get it to come out of the nest box to be seen. Because of this rough treatment and the wetting that the weasel gave itself by jumping in and out of its water dish, I had some fear for its health. It appeared sick in the morning, and spent the day curled up in the dry excelsior shivering miserably. During the night, however, it had eaten a half-grown rice rat, and the next morning it seemed well except for a little stiffness. From then on it gave every evidence of abundant health.

Reactions to Other Animals.—One night a large 'coon dog was brought in to see the weasel, which had been enjoying its evening romp on the table. Catching sight of the great hound, the weasel took a position from which it could reach the protection of its cage in one jump. ''Freezing'' there, it watched with an attitude of mixed awe and curiosity the big beast which, encouraged by its owner, presently broke into a loud bay. Upon this the weasel scrambled hastily into the cage and moved nervously back and forth peering at the bellowing giant. When on a different occasion a freshly-stretched racoon pelt was held up to its cage so that the weasel could see and smell it, he fairly squalled defiance at the pelt, and his face was a picture of hate and ferocity as he acted as though trying to get at the pelt through the side of the cage.

When the weasel appeared annoyed or seemed to feel imposed upon, it stamped its hind feet. Seton (1926: 329) considers this same act by the common skunk to be one of warning. In this Florida weasel it appeared to be an act of warning or defiance.

Bold and courageous in behavior, the weasel never showed fear of man unless the circumstances seemed fully to warrant it. On the other hand, it rarely showed any disposition to trust people. Although it frequently touched me and occasionally climbed into my hand, never in the seventy-one days of our acquaintance did the weasel let me touch it. Hands were laid forcibly upon the weasel only at the dictation of necessity, and bites were expected and received.

On one occasion, when I was removing droppings from the cage with small forceps, the weasel ''tackled'' my hand, hugging it and wrestling with it in a most playful manner. My responding as one plays with a kitten or a puppy, however, only led to the little killer's biting harder and harder until it was accordingly punished. At other times it used my proffered hand as a step in getting out of the cage, jumping first to my hand and then from it to the cage top. On such occasions it sometimes stopped in my hand to nip at it or to examine the cuff, but at the slightest move of my other hand to pet it, the weasel was gone.

Several things served, at least to some extent, to heighten the weasel's fear and distrust. When the weasel was etherized to be measured, its return to consciousness was followed by a period of suspicion. Attempts to teach it not to bite so hard—by scolding it or rapping it with the forceps—brought mostly resentment and further shyness. On a few occasions, when it was necessary to cut short the weasel's play period on the floor, a curious strategem was employed which doubtless increased the weasel's distrust. This involved setting several live traps at strategic points on the floor and rushing after the little beast with loud shouts, stampings, and poundings, frightening it so that it rushed headlong into the nearest of the traps—which until then it had disdained to enter. The influence of these things seemed to be only temporary, however, or at most added but little fuel to a great natural fire of distrust.

Curiosity.—The weasel's endowment of curiosity seemed immense. Before it had ever been let out of its cage, and while it was shut in the nest box during the cleaning of the cage, it tried repeatedly to claw the door of the box open. This made it necessary to hold the nest box door shut to prevent the weasel's escape. Exasperated by its persistence on one occasion, I finally let the animal have its way. Cautiously but determinedly it crept out, its eyes bright with excitement and its nose keenly testing the air. Always keeping me within the field of its vision, it proceeded to explore the whole top of the study table upon which it found itself, and to sniff at and examine every article on it with unflagging curiosity. Talking to the weasel in a low conversational tone, I finished cleaning the cage. It paid me little attention, except to use any sudden movement or noise that I made for an excuse to scamper. After a while I gently placed a clean mouse cage on the table with the outer door of the nest box open. The weasel walked in curiously to inspect this, and I quietly shut the door.

For some time thereafter the weasel was allowed the run of the study table for a while each night. Its curiosity led it to do many things, but, as already stated, never to essay the jump to the floor. Once, while the cage was being cleaned, a gallon jar of leaves which had just been gathered was placed upon the table. The weasel slyly climbed into it for a cautious but thorough inspection, literally getting to the bottom of the matter. Only the night before the weasel had stood on its head in a pint jar trying to get into it. Its first adventures on the floor were affairs in which its curiosity was given full scope. Table legs, chairs, traps, jars—everything was new and fascinating. Even when the weasel had been let out on the floor of the room every night for several weeks, it seemed to find many things of interest.

Playfulness.—Hand in hand with curiosity went playfulness. This was first noticed on the third day of the weasel's captivity when it was observed sprawled on its back in the doorway of its nest box toying with the door. For minutes at a time the weasel scratched at it, bit it, and tugged it up and down with its teeth. After it had become accustomed to its environment, the animal invariably played with its food, leaping upon it from every angle, biting it, rolling over and over, wrestling with it, tossing it about, and ''killing'' it again and again. Whenever fresh bedding of excelsior or oak leaves was provided in the cage, the weasel rolled and romped in it and wormed its way through and through it.

When its playground widened to include my table top, many more playthings became available. It pushed ink bottles about, rolled vials back and forth, wrestled with an electric extension cord, essayed to climb the goose-necked table lamp, jumped in and out of its cage, and wrestled with the large feet indecorously propped on the table. From one thing to another it dashed, pausing and posing charmingly at the end of each short rush, a superb picture of grace and alertness. Attracted by my hand on the table the weasel crept up to it and sniffed it. If the hand stayed there, the weasel nipped it gently and ran away, and then presently returned to sniff and nip and run again. This continued with the nip growing harder each time, eventually provoking a shout and a vigorous cuff which always missed the quick rascal. Lurking furtively behind objects at the far side of the table until the scolding tone went out of the voice which addressed it, the weasel then came forth once more to start another game of some kind.

A canvas laundry bag which lay on the table had a wonderful appeal for the weasel. When the mouth of it was propped open, the creature would cautiously creep into it and around inside of it exploring. Playfully I sometimes clapped my hand over the weasel inside the bag, and mauled it gently. This usually caused him to rush precipitantly out of the bag, but within a few minutes he often crept back in again. On some occasions I closed the mouth of the bag, trapping the weasel inside, and mauled it gently or gloated over it in a loud and threatening voice and even took the bag up and shook it. Then I laid the bag down on the table again and feigned innocence while the weasel crept slowly out, mussed and ruffled-looking, and eyeing me suspiciously. The air on these occasions became heavily laden with the strong, musky odor previously mentioned. After a still moment or so the weasel gave a carefree, little hop as if to show that it had really not been scared at all, and proceeded to find interest in something else.

When enjoying the greater freedom of the wide, smooth concrete floor, the weasel appeared to have a good time running and making abrupt, sliding turns and stops, like a boy playing on ice. It also climbed among my stacks of live traps, doubtless to enjoy the crash and clatter which it frequently managed to create by knocking over a stack. And if repetition indicates enjoyment the weasel took much pleasure in clambering about among the rungs of the chair under me and nipping at my absent-mindedly proffered fingers.

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EDITORIAL POLICIES OF THE PROCEEDINGS

During the nine years of its existence the Florida Academy of Sciences has undergone a notable growth and development, in which the Proceedings has shared. It is now time to bring to the attention of the membership of the Academy, and of others who may wish to publish in our journal, a statement concerning the editorial policies which have been adopted as a result of these nine years of experience.

When the Academy was founded in 1936, provision was made for the publication of an annual volume, to include not only scientific papers presented at the annual meetings, but also such records of the Academy as the Council should direct. As our membership grew and an increasing number of papers was submitted for publication, the size of the annual volume rose from the 170 pages of volume 1 (1936) to 370 pages in volume 5 (1940), with a corresponding increase in the labor of editing as well as in cost. During this period the Proceedings was edited almost solely for the benefit of Academy members. Papers by non-members were not eligible for publication, and almost all papers presented at the annual meetings were printed in full or as abstracts. Little consideration was given to the content of papers so long as they were (or could be made) acceptable in form. This was in accord with the announced policy of the Academy to encourage non-professional and serious amateur work in the sciences by every means—a policy which has been and will continue to be maintained.

Partly as a result of the cost of publishing the Proceedings, the Academy found itself in financial difficulties by 1940. This crisis was met and gradually overcome by a variety of measures, and we are greatly indebted to the officers and other members who devoted their time and efforts to solving the problem. Especial mention should be made of the help given by Dr. L. Y. Dyrenforth and Mr. Sidney L. Stubbs (respectively Editor and Associate Editor for some years), not only for their valuable suggestions but also for generous financial assistance.

Among the steps taken by the Council to insure continued publication of our journal while reducing its net cost to the Academy, was the decision to make it a quarterly periodical, of such quality that it might rank among nationally recognized scientific publications. By this means it was hoped gradually to increase subscriptions by libraries and non-members, and thus to bring in additional outside revenue to aid in supporting the journal. This policy has already begun to bear fruit; but it has entailed a change in the status of the Proceedings relative to our members which needs to be clearly understood.

The most important departures from previous practice are those of accepting papers from non-members as well as from members of the Academy, and of selecting all papers solely on the basis of merit and interest. Papers may be submitted by anyone at any time, and need not have been presented at a meeting of the Academy. It seemed necessary to thus broaden the sources from which we might draw, since our own membership is too limited to furnish a continuous and sufficiently varied supply of papers of high quality. All papers will have to be scrutinized more closely than before, with regard both to content and to standards of presentation, since if our journal is to attain wide recognition and demand it must compare favorably with national periodicals of recognized merit. We hope that the bulk of the papers published will continue to be those of our own members, and feel confident that they will meet the challenge conveyed by the revised editorial policies. This can be done if papers submitted by members are prepared as carefully and as conscientiously as they would be for any professional journal of national scope.

Selection of papers for publication is the responsibility of the editor; but in this important, often difficult, and always delicate task he will be aided and advised by many persons, both within and outside of the Academy membership, who have been chosen for their scholarship, judgment, willingness to serve, and knowledge of their subjects. In all doubtful instances, and especially in the many fields unfamiliar to the editor, the advice of these associates will be sought. On account of space limitations, some (or perhaps many) papers which would merit publication in full may have to be printed in the form of abstracts, if they are to appear in our journal. The cooperation of authors in preparing suitable abstracts is therefore solicited. Two further points relative to the selection of papers should be mentioned. One criterion is the ''durability'' of a contribution; papers that are likely to retain value for some time will be given preference over those of ephemeral interest. A second consideration is regional. Because this is the Florida Academy, papers relating to Florida or to the southeastern states will be given priority over those of the same class and merit which relate principally to other regions. Naturally this criterion is not applicable to papers in such fields as mathematics, physics, chemistry, etc., nor to comprehensive studies in general; and where it does apply it is secondary to considerations of quality and interest.

We shall try to balance the contributions from the various fields of science, but how well this balance can be maintained will depend largely on what is available for publication at a given time. Inspection of past volumes of the Proceedings will show that we have printed many more papers in the pure and applied phases of biology than in the physical and social sciences. This may be because there are more biologists (in the wide sense) than there are physical and social scientists—or perhaps only that there are more of the former who submit papers. Whatever the explanation, if this disproportion continues it will be reflected in the pages of our publication.

In deciding to adopt the quarterly form, the Council at the same time voted to change the name of our journal from ''Proceedings'' to ''Quarterly Journal,'' as being more descriptive, and tending to set it apart from the annual publications of most of the state academies. This change has not as yet been made; but beginning with volume 8 the official title will be ''Quarterly Journal of the Florida Academy of Sciences.'' For the sake of continuity, volume 8 will also bear the name ''Proceedings'' in parentheses, but this will be omitted from subsequent volumes.

Every editor of the Proceedings has found the difficulty of his task increased by the great variation in methods of citation, use of footnotes, spelling, punctuation, etc., encountered in the manuscripts sent him, and several unsuccessful attempts were made to set up and enforce regulations governing such points. It is now contemplated that we make use of a brief style manual[1] which the University of Florida Press expects to issue, and which will be available to members of the Academy and to others who care to obtain it. By following its suggestions authors may considerably reduce the labor of editing their manuscripts, and thus hasten their publication. In a journal such as ours, covering a wide variety of fields, complete consistency in such matters should neither be expected nor required, since not all presentations are adapted to any single mode of treatment. Nevertheless, the greatest uniformity consistent with these varying requirements will add both to the appearance and the usability of our publication, and manuscripts that depart too far from these rather flexible standards will have to be returned to the authors for alteration.

The cost of all cuts, and of tabular material if it is large in amount or has to be set by hand, must be paid by the author.

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[1] The editor of the Proceedings has been invited to cooperate with the editor of the University of Florida Press in the preparation of this manual.

Galley proof, and when necessary page proof, will be sent to the author for correction. The prices charged for reprints, sometimes excessive in the past, are now in line with those of other scientific journals published in the United States (see table below). Reprints should be ordered at the time proof is returned, and payment for cuts, tables, and reprints should be made to the Managing Editor.

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Diettrich, Sigismond deR.—University of Florida, Gainesville. (Geography)
Disher, Dorothy—Florida State College for Women, Tallahassee. (Psychology)
Dodd, Dorothy—State Library, Tallahassee. (History—Archives)
Dolbeare, H. B.—University of Florida, Gainesville. (Economics)
Dostal, B. F.—University of Florida, Gainesville. (Mathematics)
Drosdoff, Matthew—U. S. Department of Agriculture, 146 Florida Court, Gainesville. (Soil Science—Horticulture)
Durham, Clarence—Box 739, Gainesville. (Physical Science and Mathematics)
Dyrenforth, L. Y.—St. Lukes Hospital, Jacksonville. (Medicine and Chemistry)
Dyrenforth, Mrs. L. Y.—3885 St. Johns Ave., Jacksonville 5. (Medicine)
Edwards, Herman M.—Memorial Chapel, Rollins College, Winter Park. (Religion)
Edwards, Richard A.—University of Florida, Gainesville. (Geology)
Edwards, W. T.—State Department of Education, Tallahassee. (Education)
Elliott, John E.—3404 Yoakum Bldg., Houston, Texas. (Economics—Petroleum)
Engel, Olive—Florida State College for Women, Tallahassee. (Chemistry)
English, J. Colin—State Superintendent of Public Instruction, Tallahassee. (Education)
Erch, G. H.—Wiersdale. (Agriculture and Horticulture)
Evans, Elwyn—157 E. New England Ave., Winter Park. (Medicine)
Fairchild, David—4013 Douglas Road, Miami. (Botany)
Fargo, William G.—506 Union St., Jackson, Michigan. (Ornithology—Geology)
Faust, Burton K.—U. S. Patent Office, Division 34, Richmond, Virginia. (Physics and Mathematics)
Fawley, Gladys—Florida State College for Women, Tallahassee. (Geography)
Fernald, H. T.—1128 Oxford Road, Winter Park. (Zoology)

Field, Howard M.—Box 161, Rollins College, Winter Park. (Last known address) (Zoology)

Fifield, W. M.—University of Florida, Agricultural Experiment Station, Gainesville. (Horticulture)

Finner, P. F.—Florida State College for Women, Tallahassee. (Psychology)

Firestone, Richard—Rollins College, Winter Park. (Modern Languages)

Fischer, Alfred G.—Florida Geological Survey, Tallahassee. (Geology)

Floyd, B. F.—Davenport. (Horticulture)

Foote, P. A.—University of Florida, Gainesville. (Pharmacy)

French, Robert M.—Shark Industries, Hialeah. (Biology-Nutrition)

Fuller, Dorothy L.—Stetson University, DeLand. (Biology)

Gager, William A.—University of Florida, Gainesville. (Mathematics)

Gager, Mrs. William A.—3421 19th Ave., S., St. Petersburg. (Biology)

Galbraith James—Tharp St., Tallahassee. (Geology)

Getting, Robert E.—Box 2642, University Station, Gainesville. (Physics)

Gifford, John C.—University of Miami, Coral Gables. (Forestry)

Goette, W. L.—P. K. Yonge Laboratory School, Gainesville. (Physical Sciences)

Goin, Coleman J.—University of Florida, Gainesville. (Herpetology)

Goin, Mrs. Olive B.—University of Florida, Gainesville. (Zoology)

Goulding, R. L.—Florida State College for Women, Tallahassee. (Education)

Graham, Viola—Florida State College for Women, Tallahassee. (Physiology)

Gratz, L. O.—University of Florida, Agricultural Experiment Station, Gainesville. (Plant Pathology)

Gray, Clarence A.—R.F.D., Homestead. (Physical Science)

Gray, Susan W.—George Peabody College, Nashville, Tennessee. (Psychology)

Grout, A. J.—Manatee. (Bryology)

Gunter, Herman—Florida Geological Survey, Tallahassee. (Geology)

Gut, H. J.—Box 700, Sanford. (Vertebrate Paleontology)

Hamilton, H. G.—University of Florida, Agricultural Experiment Station, Gainesville. (Agricultural Economics)

Hanna, A. J.—Rollins College, Winter Park. (History)

Hanna, Mrs. Kathryn Abbey—235 Sterling Ave., Winter Park. (History)

Harkness, William J. K.—Ontario Fisheries Research Laboratory, University of Toronto, Toronto, Ontario, Canada. (Limnology)

Harper, Roland H.—Geological Survey, University of Alabama, Tuscaloosa, Alabama. (Plant Geography)

Harrison R. W.—1235 Alhambra Circle, Coral Gables.

Hart, J. Sanford—172 Eglinton Ave. W., Toronto, Ontario, Canada. (Ichthyology-Physiology)

Hart, Sister Mary Jane, O. P.—Barry College, Miami. (Chemistry)

Hasbrouck, Alfred—422 Holt Ave., Winter Park. (Hispanic American History)

Hawkins, J. E.—University of Florida, Gainesville. (Chemistry)

Hayward, Wyndham—Lakemont Gardens, Winter Park. (Horticulture)

Heath, Frederick H.—University of Florida, Gainesville. (Chemistry)

Heinlein, C. P.—Florida State College for Women, Tallahassee. (Psychology)

Henry, Mildred V.—Seed Laboratory, State Department of Agriculture, Tallahassee. (Botany)
Hjort, E. V.—University of Miami, Coral Gables. (Chemistry)
Hoagland, Elizabeth—1231 LeBaron St., Jacksonville. (History)
Hobbs, H. H., Jr.—University of Florida, Gainesville. (Zoology)
Hodsdon, L. A.—418-20 Security Bldg., 117 NE. 1st Ave., Miami. (Herpetology)
Holt, Mrs. J. R.—Box 627, West Palm Beach. (Economics)
Hood, Mary N.—1561 Stockwell Hall, University of Mich., Ann Arbor, Mich. (Bacteriology)
Hood, Samuel C.—Bradenton Trailer Park, Bradenton. (Historical Research)
Hopkins, R. H.—Box 409, Hawthorn. (Mining Engineering)
Hosic, James F.—1521 Highland Road, Winter Park. (Education)
Housman, Bertha N.—305 Woodward St., Tallahassee. (Home Demonstration)
Houston, Alfred—Box 590, St. Augustine. (Law)
Howard, John N.—1551 E. Blvd., Cleveland 6, Ohio. (Chemistry)
Hubbell, Rosemary L.—Alpha Chi Omega House, Tallahassee. (Social Science)
Hubbell, T. H.—University of Florida, Gainesville. (Zoology)
Hull, F. H.—University of Florida, Agricultural Experiment Station, Gainesville. (Agronomy)
Hume, H. H.—University of Florida, Gainesville. (Botany)
Ilsley, Lucretia L.—Florida State College for Women, Tallahassee. (Political Science)
Imeson, Charles V.—Chattahoochee. (Maya Archeology)
Jackson, Miss E. S.—Florida Southern College, Lakeland. (Sociology)
Jacobs, William F.—State Forestry Office, Tallahassee. (Forestry)
Jelks, Ruth—2106 St. Johns Ave., Jacksonville. (History)
Jones, Hastings W.—U. S. Department of Agriculture, Soil Conservation Section, District Office, Tallahassee. (Agriculture)
Josefsberg, Icio Eric—Florida State Hospital, Chattahoochee. (Psychiatry)
Joubert, William—University of Florida, Gainesville. (Economics)
Keenan, Edward T.—Keenan Soil Laboratory, Frostproof. (Soil Science)
Kelley, Jerry B.—Florida State College for Women, Tallahassee. (Mathematics)
Kent, Olga M.—3850 Ponciana Ave., Coral Gables. (Home Demonstration)
Kinser, B. M.—Eustis. (Geology)
Knipp, Charles T.—Rollins College, Winter Park. (Physics)
Komarek, E. V.—Sherwood Plantation, Route 1, Tallahassee. (Biology)
Kurz, Herman—Florida State College for Women, Tallahassee. (Botany)
Laessle, Albert M.—University of Florida, Gainesville. (Botany)
LaFuze, G. Leighton—University of Virginia, Charlottesville, Virginia. (History)
Laub, C. Herbert—Puritan Hotel, Tampa. (History)
Larson, Olga—Florida State College for Women, Tallahassee. (Mathematics)
Lashley, Karl S.—4607 Ortega Blvd., Jacksonville. (Psychology)
Lautz, Amalia—University of Tampa, Tampa. (Nutrition)
Law, Eleanor—Alpha Chi Omega House, Tallahassee. (Modern Language)
Leake, James Miller—University of Florida, Gainesville. (History)
Leigh, Townes R.—University of Florida, Gainesville. (Chemistry)

Lewis, L. J.—Florida State College for Women, Tallahassee. (Chemistry)
Long, Winifred O.—3020 43rd St., St. Petersburg. (Botany)
Longstreet, R. J.—610 Braddock Ave., Daytona Beach. (Psychology)
Loucks, Kenneth W.—Citrus Experiment Station, Lake Alfred. (Plant Pathology)
Lutz, Nancy E.—San Jose Blvd., Jacksonville. (Botany)
Lyerly, J. G.—516 Greenleaf Bldg., Jacksonville. (Neurological Surgery)
Lynch, S. J.—c/o Subtropical Experiment Station, Homestead. (Subtropical Horticulture)
Lynn, Edith E.—Florida State College for Women, Tallahassee. (Physics)
MacDowell, Charles H.—1300 College Point, Winter Park.
MacGowan, Leroy W.—3213 Park St., Jacksonville. (Biology)
Madsen, Grace C.—Florida State College for Women, Tallahassee. (Botany)
Manchester, James G.—Shinnerock Road, Hampton Bays, New York. (Mineralogy)
Mandis, Margaret E.—602 Pleasant St., Avon Park. (General Science)
Marquis, Sister Patricia Anne—Rosarian Academy, West Palm Beach. (Botany and Zoology)
Marsh, Dorothea—Florida State College for Women, Tallahassee. (Physics)
Martin, James L.—230 Crest St., Tallahassee. (Geology)
Martin, Joel M.—T/4-17th General Hospital, ASN 34243024, APO 4660, c/o Postmaster, New York, New York.
Matherly, Walter J.—University of Florida, Gainesville. (Business Admin.)
Mattice, Royal—Florida State College for Women, Tallahassee. (Economics)
May, W. D.—c/o P. H. Senn, University of Florida, Gainesville. (Engineering)
Maynard, Sister Mary Thoma—Barry College, Miami. (Biology)
McBride—Arthur—Marine Studios, St. Augustine. (Biology)
McCracken, Ernest M.—University of Miami, Coral Gables. (Government)
McDonald, Anne—Florida State College for Women, Tallahassee. (Chemistry)
McEuen, Courtney—1721 Challen Ave., Jacksonville. (Medicine)
McEuen, Mrs. H. B.—1721 Challen Ave., Jacksonville.
McFarland, James B.—217 Magnolia Ave., Sebring. (Horticulture)
McKinnell, Isabel—Florida State College for Women, Tallahassee. (Chemistry)
McKinney, Robert S.—Tung Oil Laboratory, W. Main St., Gainesville. (Chemistry)
Mead, A. R.—University of Florida, Gainesville. (Education)
Mead, L. Vincent—805 Florida Court, Gainesville. (Mathematics and Science)
Melcher, William—Rollins College, Winter Park. (Economics)
Mendenhall, H. D.—Florida State College for Women, Tallahassee. (Civil Engineering)
Merritt, Webster—2033 Riverside Drive, Jacksonville 4. (Medicine)
Meyer, Herman—3053 SW. 21st St., Miami 35. (Mathematics)
Meyer, Max F.—3939 Loquat Ave., Miami. (Acoustics)
Miller, Mrs. Dorothy B.—University of Miami, Coral Gables. (Zoology)
Miller, E. M.—University of Miami, Coral Gables. (Zoology)
Mills, H. R.—911 Citizens Bldg., Tampa 2. (Conservation)
Moffet, Ruth, University of Tampa, Tampa. (Physical Education)
Moore, Coyle E.—Florida State College for Women, Tallahassee. (Sociology)
Moore, Joseph C.—c/o John F. Lannert, Buechel, Kentucky. (Mammals)

Moore, Virginia—Florida State College for Women, Tallahassee. (Housing and Social Conditions)

Morgan, Thomas N.—State Department of Education, Tallahassee. (Psychology)

Morse, Marian—Palm Beach Junior College, West Palm Beach. (History and Psychology)

Mowry, Harold—University of Florida, Agricultural Experiment Station, Gainesville. (Horticulture)

Munroe, D. J.—600 Midyette-Moor Bldg., Tallahassee. (Geology)

Murray, Mary Ruth—1326 SW. 1st St., Miami 35. (General Science)

Murrill, W. A.—314 Clark Lane, Gainesville. (Botany)

Netting, Graham H.—Carnegie Museum, Pittsburgh 13. (Herpetology-Geography)

Newins, Harold S.—University of Florida, Gainesville. (Forestry)

Nissen, Henry W.—Yale Laboratories of Primate Biology, Orange Park. (Psychobiology)

Osborn, Herbert—1952 Concord Road, Columbus, Ohio. (Biology)

Otto, Nan—673 W. Jefferson St., Tallahassee. (Social Sciences)

Owens, J. Harold—Knox College, Galesburg, Illinois. (Physics)

Parker, A. W.—1826 N. Orange Ave., Orlando. (Dentistry)

Parker, Daisy—Florida State College for Women, Tallahassee. (Political Science)

Parker, Garald G.—U. S. Geological Survey, Box 2529, Miami. (Geology)

Parker, Horatio N.—2777 Park St., Jacksonville. (Public Health)

Patrick, R. W.—University of Florida, Gainesville. (Social Science)

Pearson, Hazel—University of Miami, Coral Gables. (Entomology)

Pearson, Jay F. W.—University of Miami, Coral Gables. (Biology)

Penningroth, Paul W.—St. Petersburg Junior College, St. Petersburg. (Psychology)

Perry, Louise M.—Box 827, Asheville, North Carolina. (Marine Biology-Ornithology)

Perry, W. S.—University of Florida, Gainesville. (Physics)

Phelps, Isaac K.—Rollins College, Winter Park. (Chemistry)

Phipps, Cecil G.—University of Florida, Gainesville. (Mathematics and Physics)

Ponton, G. M.—2 Ballard Ave., St. Augustine. (Geology)

Popper, Annie—Florida State College for Women, Tallahassee. (History)

Powers, Hiram—133 E. Morse Blvd., Winter Park. (Modern Language)

Pressler, Edward D.—Humble Oil and Refining Company, Box 3292, Tampa. (Geology)

Raa, Ida—Route 3, Tallahassee. (Chemistry)

Rainwater, Edward H.—1305 Mitchell Ave., Tallahassee. (Geology)

Rand, William W.—Shell Oil Company, Box 525, Tallahassee. (Oil Geology)

Reed, Robert B.—St. Petersburg Junior College, St. Petersburg. (History)

Reinsch, B. P.—Florida Southern College, Lakeland. (Mathematics and Physics)

Rhodes, M. C.—115 South Newport Ave., Tampa. (Mathematics)

Richards, Harold F.—Florida State College for Women, Tallahassee. (Physics)

Riesen, Lt. Austin H., Air Corps, Altitude Training Unit, Drew Field, Tampa. (Psychology)

Roberts, Albert H.—1204 Thomasville Road, Tallahassee. (History)
Robinson, T. Ralph—Bayacre, Terra Ceia, Florida. (Horticulture)
Robinson, Winifred J.—818 Antoinette Ave., Winter Park. (Botany)
Rogers, J. Speed—University of Florida, Gainesville. (Animal Biology)
Rolfs, Clarissa—2317 N.E. 2nd Ave., Miami 37. (Citrus)
Russell, Jack C.—Celery Investigation Laboratory, Sanford. (Entomology)
Sadler, Glendy—c/o Malaria Research Laboratory, Tallahassee. (Zoology)
Sauté, George A.—Rollins College, Winter Park. (Mathematics)
Scarborough, Mrs. Christina B.—Florida State College for Women, Tallahassee. (Psychology)
Schornherst, Ruth—Florida State College for Women, Tallahassee. (Botany)
Scoggins, Lewis—426 Hillcrest Drive, Tallahassee. (State Parks and Recreation)
Scott, Edward W.—North Monroe St., Tallahassee. (Geology)
Scott, G. G.—Rollins College, Winter Park. (Biology)
Senn, P. H.—University of Florida, Gainesville. (Genetics—Plant Breeding)
Shankweiler, Paul W.—Florida State College for Women, Tallahassee. (Criminology)
Shaw, Fannie B.—Florida State College for Women, Tallahassee. (Health Education)
Shealey, A. L.—University of Florida, Gainesville. (Animal Husbandry)
Sherman, H. B.—University of Florida, Gainesville. (Biology—Mammals)
Sherman, John H.—Weber College, Babson Park. (Economics and Law)
Shippy, W. B.—Box 12, Ft. Meade. (Plant Pathology)
Shores, V. L.—Florida State College for Women, Tallahassee. (History)
Shuleman, Conrad T. B.—Florida Southern College, Lakeland. (Physics)
Simpson, J. Clarence—Florida Geological Survey, Tallahassee. (Archaeology)
Smith, Frederick B.—University of Florida, Gainesville. (Soils—Microbiology)
Smith, F. G. Walton—University of Miami, Coral Gables. (Marine Biology)
Smith, Richard M.—Box 212, Tallahassee. (Chemistry)
Snodgrass, Dena—Florida Chamber of Commerce, Jacksonville. (History)
Snyder, I. W.—Box 149, Tallahassee. (Government)
Spivey, Ludd M.—Florida Southern College, Lakeland. (Sociology)
Springer, Stewart—Box 983, Homestead. (Ecology—Conservation)
Spurr, J. E.—3324 Hankel Circle, Winter Park. (Geology)
Spurr, Stephen H.—Harvard Forest, Petersham, Massachusetts. (Forestry)
Stark, William E.—1773 Alabama Ave., Winter Park. (Education)
Stevens, H. E.—224 Annie St., Orlando. (Horticulture)
Stifler, Mrs. James M.—315 16th St., Bradenton. (Botany)
Stimson, Louis A.—1835 Oppeechee Drive, Miami 33.
St. John, Edward P.—Floral City. (Pteridophyta)
St. John, Robert P.—Floral City. (Cryptogamic Botany)
Stokes, Charles A.—c/a Godfrey L. Cabot, Inc., 77 Franklin St., Boston 10, Massachusetts.
Stokes, W. E.—University of Florida, Agricultural Experiment Station, Gainesville. (Agronomy)
Stone, Wendell C.—Rollins College, Winter Park. (Philosophy)

Stoye, Frederick H.—Mill Pond Road, Sayville, Long Island, New York. (Biology)

Stubbs, Alice C.—Whittier Hall, 1230 Amsterdam Ave., New York 27, New York.

Stubbs, Sidney A.—508 3rd Ave., Manatee. (Geology)

Swesnik, R. W.—2620 N. Broadway, Oklahoma City, Oklahoma. (Oil Geology)

Swingle, Walter T.—4753 Reservoir Road, N.W., Washington, D. C. (Botany)

Tanner, W. Lee—Box 17, Panasoffkee. (Chemistry)

Taylor, H. Marshall—11 N. Adams St., Jacksonville. (Oto-rhino-laryngology)

Thacher, Mabel Y.—129 N. Copeland Ave., Tallahassee. (Bacteriology)

Therrill, J. H.—Superintendent, State Hospital, Chattahoochee. (Hospital Administration)

Tilden, Josephine E.—"Ia ora na," Hesperides, Lake Wales. (Phycology)

Tisdale, W. B.—University of Florida, Agricultural Experiment Station, Gainesville. (Botany)

Tissot, A. N.—University of Florida, Agricultural Experiment Station, Gainesville. (Entomology)

Totten, Henry R., Major—Camp Hdqrs., Camp Blanding, Florida. (Botany)

Tracy, Annie M.—Florida State College for Women, Tallahassee. (Nutrition)

Unkelsbay, Athel G.—U. S. Geological Survey, Tallahassee. (Geology)

Van Brunt, W. E.—Telephone Bldg., Tallahassee. (Dentistry)

Van Stan, Ina—Florida State College for Women, Tallahassee. (Anthropology)

Vance, Clarence B.—Evansville College, Evansville, Indiana. (Geology)

Vance, Earl L.—Florida State College for Women, Tallahassee. (Journalism)

Vermillion, Gertrude—Apt. 2-1, 119 Livingston Ave., New Brunswick, New Jersey. (Chemistry)

Vestal, Paul—Rollins College, Winter Park. (Botany)

Vinten, C. R.—23 Water St., St. Augustine. (Park Planning)

Waddington, Guy—U. S. Bureau of Mines, Bartlesville, Oklahoma. (Chemistry)

Wade, Thomas L.—Florida State College for Women, Tallahassee. (Mathematics)

Waite, Alexander—Rollins College, Winter Park. (Psychology)

Wakefield, Marian L.—512 W. Pensacola St., Tallahassee. (Botany)

Wallace, H. K.—c/o Department of Biology, University of Florida, Gainesville. (Biology)

Wallace, Madge—2725 Lydia St., Jacksonville. (Botany)

Waskom, Hugh T.—Florida State College for Women, Tallahassee. (Psychology)

Watson, J. R.—University of Florida, Agricultural Experiment Station, Gainesville. (Entomology)

Wayman, Catherine—Tallahassee. (History)

Weber, George F.—University of Florida, Agricultural Experiment Station, Gainesville. (Biology)

West, Erdman—University of Florida, Agricultural Experiment Station, Gainesville. (Botany of Florida)

West, Frances L.—St. Petersburg Junior College St. Petersburg. (Biology)
White, Sarah P.—Florida State College for Women, Tallahassee. (Medicine)
Williams, George A.—220 Hyde Park Ave., Tampa. (Chemistry)
Williams, H. Franklin—University of Miami, Coral Gables 34. (History)
Williams, H. S.—Umatilla. (Herpetology)
Williams, R. H.—University of Miami, Coral Gables. (Botany)
Williamson, B. F.—Box 17, Gainesville. (Tung Oil Industry)
Williamson, R. C.—University of Florida, Gainesville. (Physics)
Wilson, W. Harold—University of Florida, Gainesville. (Mathematics)
Wimberly, Stan E.—University of Michigan, Department of Psychology, Ann Arbor, Michigan. (Psychology)
Witmer, Louise R.—1815 17th St. N.W., Washington, D. C. (Psychology)
Woods, E. Bryant—1110 Citizens Bldg., Tampa. (Medicine)
Work, Arthur L.—Box 1259, Tallahassee. (Mathematics)
Yothers, W. W.—457 Bonne St., Orlando. (Entomology)
Young, Frank N.—c/o Department of Biology, University of Florida, Gainesville. (Entomology)
Young, John W.—720 Glenridge Drive, West Palm Beach. (Mathematics)
Young, Sadie G.—Florida State College for Women, Tallahassee. (Economics)
Zielonka, Rabbi D. L.—University of Tampa, Tampa. (Sociology)

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ERRATA AND ADDENDA, VOLUME 7

p. 103, line 19: substitute the following: "glaucous . . . *Pinus echinata* (Shortleaf pine)."

p. 121, line 10: for **"subfastible"** read **"subfastibile."**

p. 199, following *peromyscus gossipinus restrictus,* add: *Sylvilagus floridanus ammophilus*. Type locality: "Oak Lodge," on the peninsula opposite Micco, Brevard Co., Florida.

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